CH2M HILL ENGINEERING CHANGE NOTICE

Page 1 of 2 ☒ DM ☐ FM ☐ TM

1a. **ECN** 722130 **R** 0

1b. **Proj. ECN** N/A - - R

2. **Simple Modification**	3. **Design Inputs** – For full ECNs, record information on the ECN-1 Form (not required for Simple Modifications)	4. **Date**
☒ Yes ☐ No		10/15/04

5. **Originator's Name, Organization, MSIN, & Phone No.**	6. **USQ Number**	7. **Related ECNs**
John Schofield, Retrieval/Closure Project, S7-12, 373-2245	No. - - - R - ☒ N/A	N/A

8. **Title**	9. **Bldg. / Facility No.**	10. **Equipment / Component ID**	11. **Approval Designator**
C-200-Series Tanks Retrieval Functions and Requirements	C-200/241-C	C-200-Series Tanks	EQ

12. **Engineering Documents/Drawings to be Changed** (Incl. Sheet & Rev. Nos.)	13. **Safety Designation**	14. **Expedited/Off-Shift ECN?**
RPP-16525 Revision 5	☐ SC ☐ SS ☐ GS ☒ N/A	☐ Yes ☒ No

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17. **Description of the Change** (Use ECN Continuation pages as needed)

RPP-16525 Revision 5 is replaced in its entirety by this Revision 6.

18. **Justification of the Change** (Use ECN Continuation pages as needed)

Revision required based upon comments from Washington Department of Ecology

The USQ process is N/A for this document change. No facility modifications, procedure changes, or tests/experiments are affected by this revision. JSS 10/15/04

19. **ECN Category**

☒ Direct Revision
☐ Supplemental
☐ Void/Cancel

ECN Type

☐ Supercedure
☐ Revision

20. **Distribution**

Name	MSIN	Name	MSIN
J. S. Conrad	S7-03	W.T. Thompson	S7-70
J.S. Boettger	S7-24	J.C. Henderson	S7-70
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M.N. Jarayssi	H6-03	CH2M EQRG	R1-14
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D.G. Baide	S7-70		
J.J. Luke	H6-03		

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21. **Revisions Planned** (Include a brief description of the contents of each revision)
Complete revision based upon comment incorporation.

Note: All revisions shall have the approvals of the affected organizations as identified in block 11 "Approval Designator," on page 1 of this ECN.

22. **Design Basis Documents** ☒ Yes ☐ No

23. **Commercial Grade Item Dedication Numbers** (associated with this design change)
N/A

24. **Engineering Data Transmittal Numbers** (associated with this design change, e.g., new drawings, new documents)
N/A

25. **Other Non Engineering (not in HDCS) documents that need to be modified due to this change**

Type of Document	Document Number	Update Completed On	Responsible Engineer (print/sign and date)
Alarm Response Procedure	N/A	N/A	N/A
Operations Procedure	N/A-completed prior to ECN	N/A	D.B. Parkman / D.B. Parkman 10/15/04
Maintenance Procedure	N/A	N/A	N/A

Type of Document	Document Number	Type of Document	Document Number
N/A	N/A	N/A	N/A

26. **Field Change Notice(s) Used?**
☐ Yes ☒ No
If Yes, Record Information on the ECN-2 Form, attach form(s), include a description of the interim resolution on ECN Page 1, block 17, and identify permanent changes.

NOTE: ECNs are required to record and approve all FCNs issued. If the FCNs have not changed the original design media then they are just incorporated into the design media via an ECN. If the FCN did change the original design media then the ECN will include the necessary engineering changes to the original design media.

27. **Design Verification Required?**
☐ Yes ☒ No
If Yes, as a minimum attach the one page checklist from TFC-ENG-DESIGN-P-17.

28. **Approvals**

Facility/Project Signatures		Date
Design Authority	E.W. Girgis *E.W. Girgis*	10-18-04
Resp. Engineer	D.G. Baide *D.G. Baide*	10-15-04
Resp. Manager	W.T. Thompson *W.T. Thompson*	10-18-04
Quality Assurance	M.C. Tipps *Michael C. Tipps*	10/18/04
IS&H Engineer	N/A	
NS&L Engineer	N/A	
Environ. Engineer	J.S. Conrad *J.S. Conrad*	10/18/04
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Other	Project Manager P.M. Branson *P.M. Branson*	10/15/04
Other	M.N. Jarayssi *M. Jarayssi*	10/19/04
Other	D.B. Parkman *D.B. Parkman*	10/15/04
Other	J.S. Schofield *John Schofield*	10/15/04
Other	N/A	
Other	N/A	

A/E Signatures		Date
Originator/Design Agent	C. Henderson *Per telecon John Schofield for Colin Henderson*	10/15/04
Professional Engineer	N/A	
Project Engineer	N/A	
Quality Assurance	N/A	
Safety	N/A	
Designer	N/A	
Environ. Engineer	J.J. Luke *[signature]*	10/19/04
Other	N/A	
Other	N/A	

DEPARTMENT OF ENERGY / OFFICE OF RIVER PROTECTION
Signature or a Control Number that tracks the Approval Signature

ADDITIONAL SIGNATURES

C-200-Series Tanks Retrieval Functions and Requirements

P.M. Branson
CH2M HILL Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

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Key Words: C-201; C-202; C-203; C-204; Tanks Retrieval Functions and Requirements

Abstract: This document establishes the C-200-Series Tanks Waste Retrieval System Functions and Requirements.

Barbara Walski 10/20/04
Release Approval Date

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Tank Farm Contractor (TFC) **RECORD OF REVISION**	(1) Document Number RPP-16525	Page 1

(2) Title

C-200-Series Tanks Retrieval Functions and Requirements

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Resp. Engr. (print/sign/date)	(6) Resp. Mrg. (print/sign/date)
1	C-200-Series Tanks Retrieval Functions and Requirements	P.M. Branson 8/20/03	W.T. Thompson 8/26/03
2	Complete rewrite due to comments received from the Washington State Department of Ecology, per ECN 721155, Rev 0	P.M. Branson 11/20/03	W.T. Thompson 11/20/03
3	Section 4.2.1, paragraph 3, page 22 revised	P.M. Branson 1/20/04	W.T. Thompson 1/20/04
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6 RS	Complete revision per ECN 722130, Rev 0 based on comments received from the Washington State Department of Ecology	DG Baide DG BAIDE 10/20/04	W.T. Thompson W.T. Thompson 10/20/04

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EXECUTIVE SUMMARY

This document establishes the functions and requirements required by Milestone M-45-00 of the *Hanford Federal Facility Agreement and Consent Order*[1] for the retrieval of mixed waste stored in the C-200-series tanks. All four of the C-200-series tanks are designated as assumed leaking tanks and are located in the 200 East Area of the Hanford Site. The retrieval of waste from the C-200-series tanks will integrate leak detection, monitoring, and mitigation with retrieval technologies to minimize the potential for leaks to occur during retrieval and to minimize the leak volume should a leak occur.

The goals of this waste retrieval deployment are to remove waste to the limit of the technology, including the retrieval of 99% (no more than 30 cubic feet residual per tank) of tank contents by volume. Waste retrieval from the C-200-series tanks will utilize a vacuum-based retrieval process that introduces limited volumes of water to mobilize solids in the tanks that are then removed using vacuum as the motive force. Any water added will be in close proximity to the vacuum head, which will reduce the potential for liquid to pool in the tank.

This functions and requirements document establishes the C-200-series tanks waste retrieval system specifications (including leak detection, monitoring, and mitigation system specifications). The specifications are based on the use of leak detection and monitoring technologies that are consistent with the vacuum-based retrieval system and consider human health risks associated with the tank waste and potential waste volumes that could leak during retrieval.

The waste retrieval system being deployed inherently reduces the potential for leakage to occur and the resulting volumes if a leak were to occur. Therefore, the risk-based leak detection and monitoring strategy is based on preventing leakage, minimizing leak volumes if a leak should occur, and using available process control data for performing mass balance leak detection within the C-200-series tanks.

[1] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

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CONTENTS

APPENDICES

FIGURES

TABLES

LIST OF TERMS

AEA	*Atomic Energy Act of 1954*
AMS	articulated mast system
BBI	best-basis inventory
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
F&R	functions and requirements
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HI	hazard index
HIHTL	hose-in-hose transfer line
HTWOS	Hanford Tank Waste Operations Simulator
ILCR	incremental lifetime cancer risk
LDM	leak detection and monitoring
LDMM	leak detection, monitoring, and mitigation
ORP	Office of River Protection
RCRA	*Resource Conservation and Recovery Act of 1976*
SST	single-shell tank
TBP	tributyl phosphate
WRS	waste retrieval system
WUF	waste unaccounted for

1.0 INTRODUCTION

The River Protection Project mission includes storage, retrieval, immobilization, and disposal of high-level mixed radioactive waste presently stored in 177 underground tanks located in the 200 East and 200 West Areas of the U.S. Department of Energy (DOE) Hanford Site. The River Protection Project is in the process of accelerating single-shell tank (SST) waste retrievals. The C-200-series tanks (C-201, C-202, C-203, and C-204), located in the 200 East Area, are four of the tanks for which the schedule for waste retrieval has been accelerated (Figure 1). These tanks were chosen for early retrieval because they will provide the following:

- High solids feed to the Waste Treatment Plant (WTP) while not further constraining available double-shell tank (DST) space.
- Existing waste transfer infrastructure from tank C-106 retrieval activities will be available to reduce overall waste retrieval costs through continuity in operations.
- Retrieval their waste will contribute to closure of the C tank farm.
- Retrieval their waste will demonstrate the vacuum retrieval system in an actual waste tank for the first time and provide operational experience for future waste retrievals.

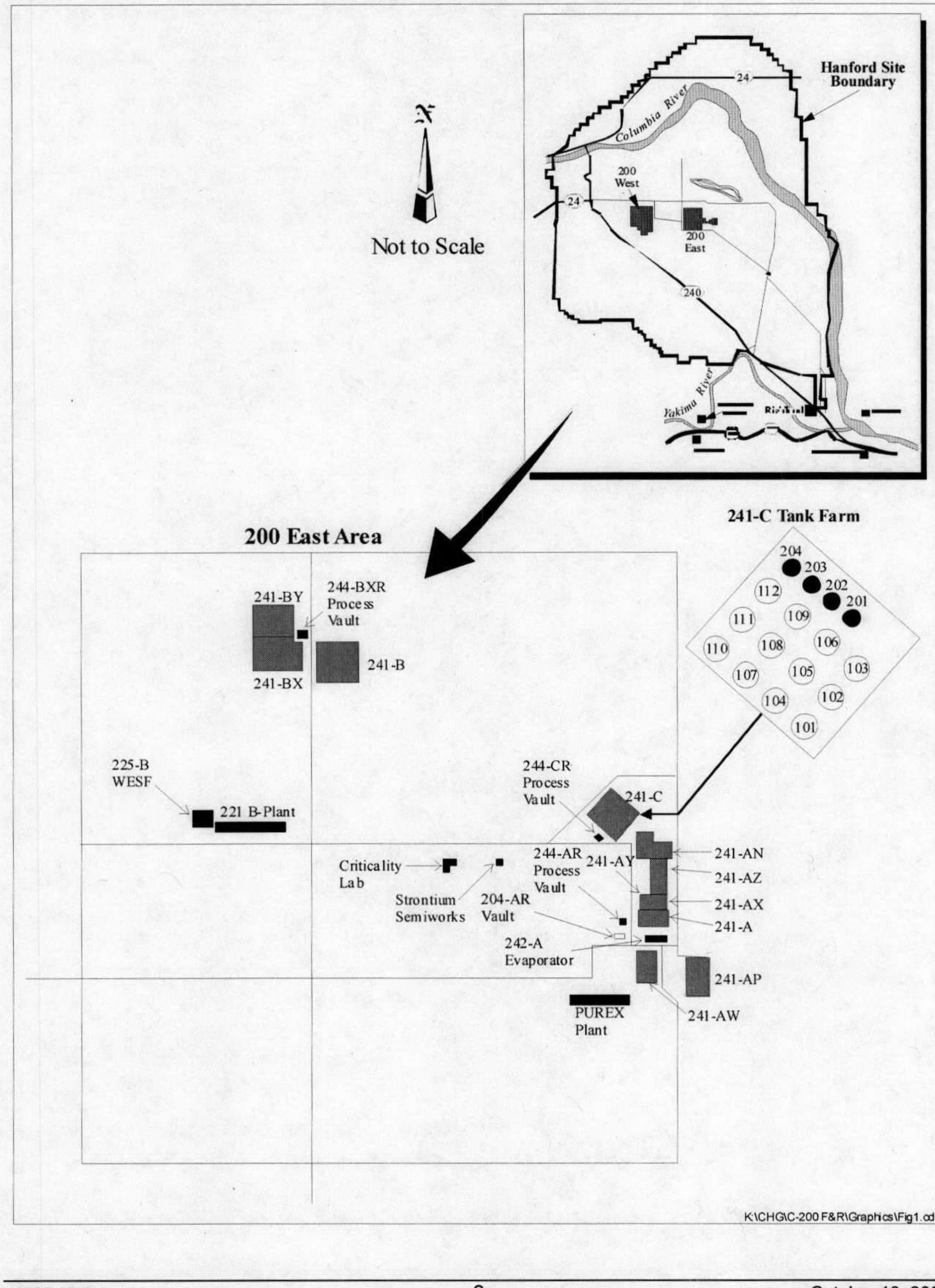
Because of the recent schedule acceleration, tank-specific waste retrieval milestones have not been established in the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989) for the C-200-series tanks. However, this functions and requirements (F&R) document has been prepared to serve as a waste retrieval F&R document. This document follows a streamlined approach to developing waste retrieval F&R documents that was developed after issuing the F&R documents for waste retrieval in tanks C-104, S-102, and S-112.

Because of concerns related to the liquid containment integrity of the older SSTs, current plans call for retrieving the SST waste and staging it in the more reliable DSTs to serve as feed material for the waste immobilization process. Although waste retrieval is a significant closure action, it does not constitute final closure. The C-200-series waste retrieval activities will be conducted, to the extent practical, to meet requirements that allow ultimate closure of the tanks and the tank farm. Therefore, the steps taken to retrieve waste from the C-200-series tanks will not preclude any future closure decisions.

The approach used to develop this document includes an integrated waste retrieval and leak detection, monitoring, and mitigation (LDMM) strategy that considers human health risk in the planning and development of waste retrieval system (WRS) requirements.

Please note that source, special nuclear, and byproduct materials, as defined in the *Atomic Energy Act of 1954* (AEA), as amended, are regulated at DOE facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts that, under AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. To the extent that this F&R document provides data or discussions about materials regulated by the AEA, that information is provided for informational purposes only.

Figure 1. Location Map of C Tank Farm and Surrounding Facilities in the 200 East Area



1.1 PURPOSE

This document provides the F&R necessary to support the design of the WRS for the C-200-series tanks. This document also provides a preliminary strategy commensurate with the F&R for waste retrieval and LDMM. The strategy combines leak detection and monitoring (LDM) methods that are consistent with the vacuum-based retrieval system along with an operational strategy designed to reduce the potential for leaks to occur and the resulting volume in the event a leak should occur. This document additionally provides risk information to establish a basis for making informed decisions in the event a leak is detected during waste retrieval.

1.2 SCOPE

The scope of this document is to establish the following for the C-200-series tanks:

- Waste retrieval F&R
- LDMM strategy
- Waste retrieval strategy.

The F&R identified in this document provide the foundation for the design criteria and design requirements documented in *Specification for the 241-C-200 Series Waste Retrieval System* (RPP-14075). Design specifications are used to develop the project engineering concepts, scope, and boundaries. The content of the design specifications include detailed requirements such as operating pressures, temperatures, materials of construction and control system requirements, confinement boundaries and controls, interface requirements, and similar detailed application requirements.

1.3 C-200-SERIES TANKS CONDITION

The C-200-series tanks were constructed from 1943 to 1944 and were put into service in 1947 and 1948. The tanks are first-generation tanks constructed with a dish-shaped bottom, a painted grout layer, an asphalt (waterproof) membrane, and an outer reinforced-concrete shell to maintain the structural integrity of the steel liner by protecting it from soil loads.
The reinforced-concrete shell is cylindrical and supports the steel liner, which is constructed of mild steel. The steel liner extends up the tank wall to a height of 25 feet (*Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area* [WHC-SD-WM-ER-349]).

As of January 2003, tank C-201 contained approximately 1,100 gallons of waste consisting of sludge; tank C-202 contained 800 gallons of waste consisting of sludge; tank C-203 contained 2,600 gallons of waste consisting of sludge; tank C-204 contained 2,400 gallons of waste consisting of sludge (*Characteristics of Waste in the C-200 Series of Hanford Underground Waste Tanks* [RPP-14627]). In July 2004, these tank volumes were revised downward in the Tank Waste Information Network System (TWINS) best-basis inventory (BBI). All assumptions and descriptions in this F&R are based upon the January 2003 numbers. The C-200-series tanks are presently passively ventilated. The C-200-series tanks are categorized as "assumed leakers" (*Waste Tank Summary Report for Month Ending January 31, 2003* [HNF-EP-0182]). There is no plan to change the "assumed leaker" status of the C-200-series tanks as a part of this F&R document.

An evaluation of the historical data was performed to assess whether the observed liquid level decreases observed in the tanks during the 1980s could be attributed to normal evaporation. The results of this evaluation were inconclusive. Given the uncertainty in the estimated evaporation losses, a technical basis could not be established as to whether the tanks did or did not leak. Details on the evaluation are provided in the draft *Evaluation of Liquid Losses Noted in The 241-C-200 Series Tanks in the Early 1980s* (RPP-19918).

The first waste put into the C-200-series tanks went into tanks C-201 and C-204 in 1947 and consisted of metal waste from operation of the bismuth phosphate process in the 221-B Separations Building. Tanks C-201 and C-204 were filled with metal waste by January 1948. Metal waste was then hydraulically mined from these tanks from March 1953 through January 1955. The metal waste sludge and supernate was dissolved in acid in the 244-BXR vault and then transferred to the 221-U Building where uranium was recovered from the waste using a tributyl phosphate-based solvent extraction process. After completing the removal of metal waste, both tanks were visually inspected and determined to be empty. However, given the limiting inspection method, periscope optics, residual metal waste could have been left in the tanks (*Origin of Wastes in C-200-Series Single-Shell Tanks* [RPP-15408]).

Tanks C-203 and C-204 received cold uranium (i.e., uranium that had not been irradiated in a reactor) waste from plutonium-uranium extraction (PUREX) startup testing in November 1955. The cold uranium waste was removed from tanks C-203 and C-204 in December 1955. Tanks C-201, C-202, C-203 and C-204 were then used from May 1955 through October 1956 to receive and store waste originating from research and development activities conducted at the 201-C Hot Semiworks Facility in the 200 East Area (RPP-15408).

Tanks C-201, C-202, C-203 and C-204 were not used to receive waste after being filled with waste from the 201-C Hot Semiworks Facility. The liquid in tanks C-201, C-202, C-203, and C-204 was transferred to other C farm tanks in the 1970s (RPP-15408).

2.0 RISK BASIS

This section presents the results of a preliminary evaluation of the long-term human health risks associated with waste in the C-200-series tanks and potential leaks that could occur during waste retrieval operations. Risk from inadvertent human intrusion into the C-200-series tanks following closure is also presented. The need to consider long-term human health risks in developing waste retrieval F&R was established in the HFFACO M-45 milestone series through Change Package M-45-00-01A. Milestones established by that change package required that a scoping-level risk assessment be prepared as part of the waste retrieval F&R documents. Scoping level is interpreted to be the same as a screening-level risk assessment that uses currently available data and information.

DOE and the Washington State Department of Ecology (Ecology) have recognized that there are risks associated with retrieving waste from aging SSTs, including the potential for leakage during waste retrieval. However, DOE and Ecology have also recognized that there are risks associated with continued storage of waste in the SSTs. Not retrieving the waste will result in its eventual and certain release, when the tanks ultimately fail. The C-200-series tanks are approximately 35 years beyond their design life, and continued storage will increase the potential for leakage to occur during waste retrieval. Time will make the situation worse so there is a bias for moving forward with waste retrieval and transfer of waste from the aging SSTs to the safer, more reliable DSTs as part of the overall commitment to meet the 2018 date for completing SST waste retrievals to fulfill HFFACO Milestone M-45-05 requirements.

Retrieval of all the waste from the C-200-series tanks with no leakage is the goal of the waste retrieval project. A risk evaluation was performed to provide a basis for making informed decisions during waste retrieval operations in the event a leak is detected or unexpected waste retrieval conditions arise. The risk basis was developed using estimated long-term human health risk via the groundwater pathway. The evaluation methodology is summarized in Section 2.1. Evaluation results are presented in Section 2.2. Calculation detail is provided in *C-200-Series Tanks Long-Term Human Health Risk Calculations* (RPP-20589). Risk from inadvertent human intrusion is presented in Section 2.3.

2.1 METHODOLOGY

The evaluation methodology followed a streamlined approach consistent with the goal of performing a screening-level assessment. Much of the information for the evaluation was derived from an existing Waste Management Area C risk analysis presented in Appendix C of *Single-Shell Tank System Closure Plan* (RPP-13774). The main elements of the approach can be summarized as follows:

- Focus on potential long-term groundwater pathway human health risk at the tank farm fenceline
- Use incremental lifetime cancer risk (ILCR) and hazard index (HI) as risk metrics
- Provide radiological ILCR for one indicator contaminant
- Provide noncarcinogenic chemical HI for one indicator contaminant
- Derive effects of contaminant release and transport from previous studies; involves no new contaminant transport analysis
- Use the best available existing published data and information to the maximum extent possible, with little new data generated for the creation of the document.

Risk impacts were calculated for this evaluation using the following equation:

$$R_i = I_i \times T_i \times d_i \qquad \text{Eq. 1}$$

Where:

i = indicator contaminant
R_i = risk metric (ILCR or HI)
I_i = inventory (Ci or kg)
T_i = transport transfer function (pCi/L per Ci or mg/L per kg)
d_i = health effects conversion factor (ILCR per pCi/L or HI per mg/L).

Sections 2.1.1 through 2.1.4 provide a discussion of the individual terms in Equation 1, including selection of indicator contaminants, development of contaminant inventories, derivation of transport transfer functions, and identification of exposure scenarios and health effects conversions factors.

2.1.1 Indicator Contaminant

Technetium-99 was selected as the indicator contaminant for radiological ILCR based on the results of the long-term groundwater pathway impact analysis presented in RPP-13774. The RPP-13774 analysis includes all radionuclides reported in *Inventory and Source Term Data Package* (DOE/ORP-2003-02) for which a dose factor was available. Individual radionuclide contributions are reported for technetium-99 and iodine-129. Together, technetium-99 and iodine-129 provide the majority of the total ILCR. Technetium-99 was the major driver, contributing approximately 90% of the total ILCR for the industrial scenario and approximately 96% for the residential scenario. Table 1 summarizes the individual contaminant contributions from the RPP-13774 results for the residual waste and retrieval leakage source terms. Contaminant contributions from the unplanned releases source term (past leaks and spills) as reported in RPP-13774 are very similar to those shown in Table 1.

Table 1. Individual Contaminant Percentage Contributions to Waste Management Area C Total ILCR and HI Values

Contaminant	Percentage of Total ILCR		Percentage of Total HI	
	Industrial Scenario	Residential Scenario	Industrial Scenario	Residential Scenario
Technetium-99	90.0%	95.6%	NA	NA
Iodine-129	9.9%	2.3%	NA	NA
Nitrite	NA	NA	35.6%	37.7%
Nitrate	NA	NA	4.8%	5.1%
Chromium (VI)	NA	NA	47.8%	43.7%
Uranium	NA	NA	0.1%	0.1%

Source: RPP-13774, Addendum C1, Table 28.
HI = hazard index.
ILCR = incremental lifetime cancer risk.
NA = not applicable.

Hexavalent chromium was selected as the indicator contaminant for noncarcinogenic chemical HI based on the analysis results presented in RPP-13774. The RPP-13774 analysis included all hazardous chemicals reported in DOE/ORP-2003-02 for which a toxicity factor was available. Individual chemical contributions are reported for chromium, nitrite, nitrate, and uranium. Together, those four contaminants accounted for the majority of the total HI. For the residual waste and retrieval leakage source terms, chromium contributed approximately 48% of the total HI for the industrial scenario and approximately 44% for the residential scenario (Table 1).

For this screening-level assessment, ILCR and HI values are calculated based only on the indicator contaminants. However, total ILCR and HI values can be estimated by applying the RPP-13774 contaminant contribution percentages shown in Table 1 to the indicator contaminant ILCR and HI values. For example, an estimate of the total ILCR can be made by multiplying the technetium-99 ILCR by 1/0.90 or 1/0.96 for the industrial and residential scenarios, respectively. Likewise, an estimate of the total HI can be made by multiplying the chromium HI by 1/0.48 or 1/0.44 for the industrial and residential scenarios, respectively.

2.1.2 Inventory

The C-200-series tanks indicator contaminant inventories used for this evaluation are shown in Table 2. These inventories were developed for consistency with the inventories used in the RPP-13774 analysis. Current technetium-99 and hexavalent chromium inventories shown in Table 2 are the same as those used in RPP-13774 and are consistent with the BBI estimates reported in DOE/ORP-2003-02.

Table 2. Inventory Estimates for C-200-Series Tanks

Tank	Current Inventory[a]		Residual Waste (30 ft^3 [220 gal])[b]		Potential Retrieval Leak (100 gal)[c]		Past Leak[d]	
	Tc-99 (Ci)	Cr (VI) (kg)	Tc-99 (Ci)	Cr (VI) (kg)	Tc-99 (Ci)	Cr (VI) (kg)	Tc-99 (Ci)	Cr (VI) (kg)
C-201	1.41E-02	2.29E+00	2.99E-03	4.86E-01	1.41E-04	2.29E-02	0.00	0.00
C-202	1.47E-02	2.39E+00	3.12E-03	5.08E-01	1.47E-04	2.39E-02	0.00	0.00
C-203	2.82E-02	4.57E+00	2.40E-03	3.88E-01	9.39E-05	1.52E-02	0.00	0.00
C-204	1.81E-02	2.95E+00	1.54E-03	2.51E-01	6.06E-05	9.84E-03	0.00	0.00

[a]Source: RPP-13774, Addendum C1, Table 7.
[b]Source: RPP-13774, Addendum C1, Table 8b.
[c]Source: Calculated from retrieval fluid concentrations given in RPP-13774, Addendum C1, Table 9.
[d]Source: RPP-13774, Addendum C1, Table 6.

The technetium-99 and hexavalent chromium inventories reported in the BBI for the C-200-series tanks are based on sample analyses rather than modeled data. The uncertainty in the reported inventories is provided in the BBI in terms of relative standard deviation.
The relative standard deviation reported in the BBI for the pre-retrieval inventory of technetium-99 is 138% for tank C-201, 80% for tank C-202, and 33% for tanks C-203 and C-204. The relative standard deviation reported in the BBI for the pre-retrieval inventory of

chromium is 80% for tanks C-201 and C-202 and 33% for tanks C-203 and C-204. Because the long-term human health risk estimates vary directly with inventory, these uncertainties would be expected to contribute to the uncertainty in the estimates for long-term human health risk.

Residual waste inventories shown in Table 2 are the same as those used for the RPP-13774 Base Case analysis and are based on the Selected Phase Removal data set from DOE/ORP-2003-02. The DOE/ORP-2002-02 Selected Phase Removal data set takes into account removal of selected phases of waste (e.g., sludge, supernate) during retrieval. The inventories shown are for 30 cubic feet of residual waste, which corresponds to the HFFACO Milestone M-45 interim retrieval goal for 200-series SSTs.

The waste retrieval leak inventories shown in Table 2 were calculated consistent with the approach used in RPP-13774 by multiplying the assumed retrieval leak volume by the retrieval fluid concentration as predicted by the Hanford Tank Waste Operations Simulator (HTWOS) model run described in *Hanford Tank Waste Operations Simulator (HTWOS) Model Run results for the Integrated Mission Acceleration Plan (IMAP) Unconstrained Case* (RPP-14302). A hypothetical retrieval leak volume of 100 gallons per tank was used for informational purposes only. This volume was used to provide a point of reference on the graphs and is not intended to represent anticipated waste retrieval leak volumes or leak detection limits for the C-200-series tanks.

The maximum volume of waste that could leak during waste retrieval operations is uncertain. This uncertainty is tied to the ability of the WRS to mobilize the waste from the tanks with minimal liquid volumes. The intent of deploying the vacuum-based WRS is to retrieve waste with minimal addition of water; however, water additions may be necessary and will vary depending on waste make-up and retrieval effectiveness. Only a small fraction of the water volume added to the tanks could leak because of the design of the WRS and the localized addition of liquids at the vacuum head.

Seven C farm tanks, including the four C-200-series tanks, are currently classified as assumed leakers in HNF-EP-0182. However, as discussed in RPP-13774 and DOE/ORP-2003-02, the preponderance of currently available data including data from baseline spectral gamma logging of C tank farm drywells described in *Hanford Tank Farms Vadose Zone: C Tank Farm Report* (GJO-HAN-18) supports the recognition of one pre-existing source of vadose zone contamination (past leaks) in the C tank farm, in the vicinity of tank C-105. Currently available data do not support the recognition of pre-existing sources of vadose zone contamination in the vicinity of the tanks classified as leakers in HNF-EP-0182. The past leak source term used in this evaluation is consistent with that used for the RPP-13774 analysis (i.e., one measured source of vadose zone contamination in the C tank farm, in the vicinity of tank C-105).

2.1.3 Contaminant Transport Transfer Functions

For this screening-level assessment, the effects of contaminant release and transport were taken from the existing analysis that was the most relevant to the case being studied. For the C-200-series tanks, this was the waste management area C numerical vadose zone and groundwater contaminant transport modeling analysis presented in RPP-13774. Proportionality coefficients called transport transfer functions were developed from the RPP-13774 analysis results and used in lieu of performing groundwater contaminant transport modeling. Transfer functions were applied as shown in Equation 1 to represent the unit contaminant concentration in groundwater per unit inventory released at the source.

The transfer functions used for this assessment were calculated from the results of the RPP-13774 contaminant transport analysis by dividing the model-predicted 10,000-year peak technetium-99 and chromium groundwater concentrations at the tank farm fenceline by the technetium-99 and chromium inventories released at the source. Separate transfer functions were calculated for in-tank waste (residual waste) and ex-tank waste (potential retrieval leaks). Tables 3 through 6 show the derivation of the individual transfer functions used for this assessment. Note that the waste retrieval leak transfer functions were based on RPP-13774 results for the C-100-series tanks. The RPP-13774 analysis did not include retrieval leak simulations for the C-200-series tanks because it was assumed that a dry waste retrieval method would be used for these tanks.

Table 3. Technetium-99 In-Tank Transport Transfer Function

Peak Technetium-99 Groundwater Concentration at C Tank Farm Fenceline from Residual Waste in C Farm Tanks Retrieved to HFFACO Goal (pCi/L)[a]	Technetium-99 Inventory in Residual Waste in C Farm Tanks Retrieved to HFFACO Goal (Ci)[b]	In-Tank Transport Transfer Function (pCi/L per Ci)
65	7.58	8.58

Note: Concentration shown is taken from the RPP-13774 base case simulation for a diffusion-dominated release. The concentration for the advection-dominated release case is 208 pCi/L.

[a]Source: RPP-13774, Addendum C1, Table 14.
[b]Source: RPP-13774, Addendum C1, Table 8b.

HFFACO = *Hanford Federal Facility Agreement and Consent Order.*

Table 4. Technetium-99 Ex-Tank Transport Transfer Function

Peak Technetium-99 Groundwater Concentration at C Tank Farm Fenceline from 8,000 gal Retrieval Leak From C Farm 100-Series Tanks (pCi/L)[a]	Technetium-99 Inventory in 8,000 gal Retrieval Leak from C Farm 100-Series Tanks (Ci)[b]	Ex-Tank Transport Transfer Function (pCi/L per Ci)
420	4.96	84.7

[a]Source: RPP-13774, Addendum C1, Table 14.
[b]Source: RPP-13774, Addendum C1, Table 10.

Table 5. Hexavalent Chromium In-Tank Transport Transfer Function

Peak Chromium Groundwater Concentration at C Tank Farm Fenceline from Residual Waste in C Farm Tanks Retrieved to HFFACO Goal (mg/L)[a]	Chromium Inventory in Residual Waste in C Farm Tanks Retrieved to HFFACO Goal (kg)[b]	In-Tank Transport Transfer Function (mg/L per kg)
0.001	119	8.4×10^{-6}

[a]Source: RPP-13774, Addendum C1, Table 18.
[b]Source: RPP-13774, Addendum C1, Table 8b.

Note: Concentration shown is taken from the RPP-13774 base case simulation for a diffusion-dominated release. The concentration for the advection-dominated release case is 0.003 mg/L.

HFFACO = *Hanford Federal Facility Agreement and Consent Order.*

Table 6. Hexavalent Chromium Ex-Tank Transport Transfer Function

Peak Chromium Groundwater Concentration at C Tank Farm Fenceline from 8,000 gal Retrieval Leak From C Farm 100-Series Tanks (mg/L)[a]	Chromium Inventory in 8,000 gal Retrieval Leak from C Farm 100-Series Tanks (kg)[b]	Ex-Tank Transport Transfer Function (mg/L per kg)
0.064	76.1	8.4×10^{-5}

[a]Source: RPP-13774, Addendum C1, Table 18.
[b]Source: RPP-13774, Addendum C1, Table 10.

2.1.4 Exposure Scenarios

Human health risks were calculated for two exposure scenarios, industrial and residential. Both scenarios are based on scenarios described in *Hanford Site Risk Assessment Methodology* (DOE/RL-91-45). The health effects conversion factors for both scenarios were taken from tables provided in *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-WM-TI-707). The conversion factors provide the lifetime cancer morbidity risk per unit concentration of technetium-99 in the groundwater and the noncarcinogenic chemical HI per unit concentration of hexavalent chromium in the groundwater. The conversion factor values used for this assessment are shown in Table 7.

Table 7. Health Effects Conversion Factors for Industrial and Residential Exposure Scenarios

Scenario	Technetium-99 Groundwater Unit Risk Factor (ILCR per pCi/L)	Hexavalent Chromium Groundwater Unit Hazard Factor (HI per mg/L)
Industrial[a]	1.38×10^{-8}	4.32
Residential[b]	3.36×10^{-7}	24

[a]Source: HNF-SD-WM-TI-707, Tables 22 and 23.
[b]Source: HNF-SD-WM-TI-707, Tables 26 and 27.

HI = hazard index.
ILCR = incremental lifetime cancer risk.

The industrial scenario represents 20 years of occupational exposure in an industrial setting. The receptor is an individual whose work is primarily indoors but also includes outdoor activities such as building and grounds maintenance. Contaminants enter the worker primarily through use of groundwater for drinking and showering. External exposures to irrigated soil and soil inhalation are also included.

The residential scenario represents 30 years of exposure in a residential setting. The receptor is an individual who resides on the land, grows fruits and vegetables, and raises livestock and poultry for personal consumption. Contaminants enter the receptor through use of groundwater for domestic needs (drinking, cooking, and showering); for irrigation (ingestion of produce, soil, and water; inhalation of soil and water; and external exposure); and watering livestock (ingestion of meat, poultry, and dairy products). Complete descriptions of the industrial and residential scenarios can be found in HNF-SD-WM-TI-707.

2.2 RESULTS

Evaluation results for the C-200-series tanks are provided in Section 2.2.1. The scope of this evaluation also included the development of a risk perspective for all tanks in the C tank farm. Results of a screening-level C tank farm risk assessment are provided in Section 2.2.2.

2.2.1 C-200-Series Tanks

Evaluation results for the C-200-series tanks are depicted in Figures 2 and 3. Figure 2 shows the peak groundwater pathway technetium-99 ILCR at the tank farm fenceline as a function of technetium-99 inventory in the C-200-series tanks. Figure 3 shows the peak groundwater pathway hexavalent chromium HI at the tank farm fenceline as a function of hexavalent chromium inventory in the C-200-series tanks. As discussed in Section 2.1.1, an estimate of the total ILCR and HI values can be calculated from the values shown on the plots by multiplying the plotted values by the reciprocal of the decimal percent of each indicator contaminant's contribution to the total ILCR or HI.

Figure 2. C-200-Series Tanks Incremental Lifetime Cancer Risk Plot

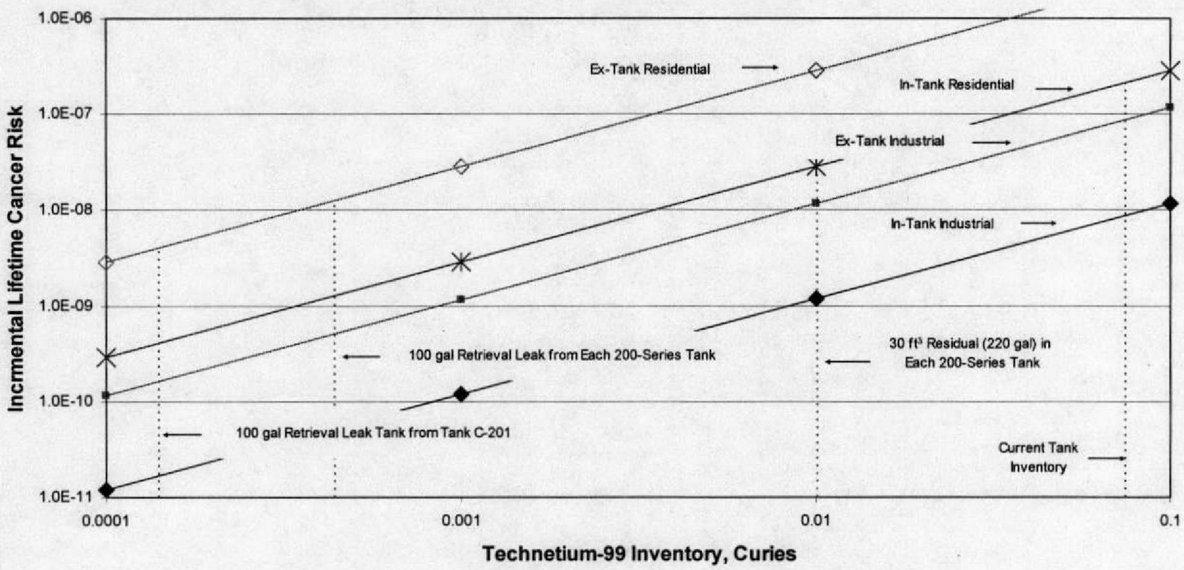
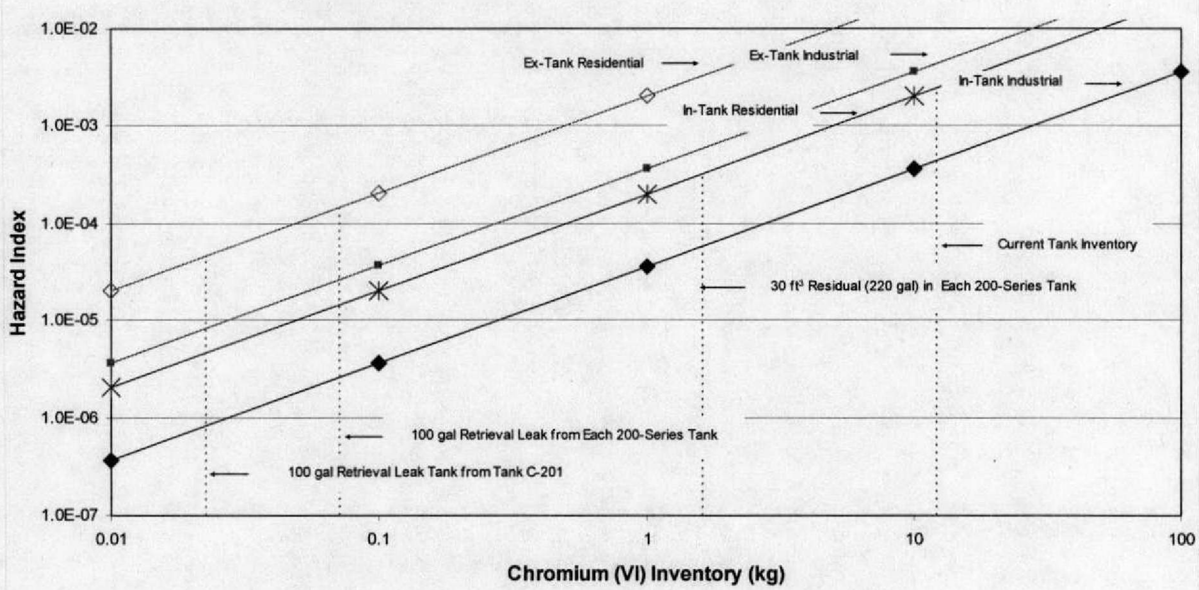


Figure 3. C-200-Series Tanks Hazard Index Plot



Four separate sloped lines are shown in Figures 2 and 3, two for in-tank waste (residuals) for the industrial and residential scenarios and two for ex-tank waste (retrieval leakage) for the industrial and residential scenarios. The data points for these lines were calculated by applying Equation 1 over a range of technetium-99 and hexavalent chromium inventory values. Vertical lines are used to indicate the estimated inventories of technetium-99 and chromium associated with several in-tank and ex-tank volumes of interest. Estimated inventories are shown for the current C-200-series tank waste, 30 cubic feet of residual waste in each C-200-series tank, a 100-gallon retrieval leak from each C-200-series tank, and a 100-gallon leak from one of the C-200-series tanks.

Figure 2 indicates that the ILCR posed by the current technetium-99 inventory in the C-200-series tanks is approximately 9×10^{-9} for the industrial scenario and 2×10^{-7} for the residential scenario. Waste retrieval down to approximately 30 cubic feet in each C-200-series tank reduces the ILCR by approximately 1 order of magnitude. The inventory of technetium-99 associated with a potential retrieval leak (ex-tank) of 100 gallons from one of the C-200-series tanks (tank C-201) is approximately 0.0001 curies and corresponds to a risk of approximately 2×10^{-10} for the industrial scenario and 4×10^{-9} for the residential scenario. A 100-gallon leak from each C-200-series tank increases the retrieval leak risk to approximately 5×10^{-10} for the industrial scenario and 1×10^{-8} for the residential scenario.

Figure 3 indicates that the HI posed by the current hexavalent chromium inventory in the C-200-series tanks is approximately 4×10^{-4} for the industrial scenario and 2×10^{-3} for the residential scenario. Waste retrieval down to approximately 30 cubic feet in each C-200-series tank reduces the HI by approximately 1 order of magnitude. The inventory of chromium associated with a potential retrieval leak (ex-tank) of 100 gallons from one of the C-200-series tanks (tank C-201) is approximately 0.02 kilograms and corresponds to a HI of approximately 8×10^{-6} for the industrial scenario and 5×10^{-5} for the residential scenario. A 100-gallon leak from each C-200-series tank increases the retrieval leak HI to approximately 3×10^{-5} for the industrial scenario and 1×10^{-4} for the residential scenario.

2.2.2 C Tank Farm

To provide a screening-level perspective of the C-200-series tanks relative to the other C farm tanks, the methodology used for the C-200-series tanks was applied to all tanks in the C tank farm. Results for the C tank farm evaluation are summarized in Tables 8 and 9 for the industrial and residential scenarios, respectively. Tables 8 and 9 show the estimated technetium-99 and hexavalent chromium inventories and associated peak ILCR and HI values by tank and source term for each tank in the C farm. The ILCR and HI values shown are groundwater pathway peak values at the C tank farm fenceline and were calculated using the approach described in Section 2.1.

Table 8. C Tank Farm Risk Evaluation Results for Industrial Scenario

Tank	Current Inventory		Residual Waste (360 ft^3 [2,700 gal] C-100 Tanks, 30 ft^3 [220 gal] C-200 Tanks)				Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak				Measured Contamination in C Tank Farm Vadose Zone			
	Tc-99 (Ci)	Cr (VI) (kg)	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI
241-C-101	6.97E-01	2.99E+02	2.13E-02	2.52E-09	9.15E+00	3.31E-04	8.66E-03	1.01E-08	3.72E+00	1.35E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-102	1.32E+00	7.35E+02	1.13E-02	1.34E-09	6.26E+00	2.27E-04	9.96E-03	1.16E-08	5.54E+00	2.01E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-103	1.34E+01	3.91E+02	7.02E-01	8.31E-08	3.33E+00	1.21E-04	2.08E+00	2.43E-06	9.88E+00	3.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-104	5.80E+01	1.46E+03	3.95E+00	4.68E-07	4.59E+01	1.66E-03	1.17E+01	1.37E-05	1.36E+02	4.94E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-105	8.14E+01	4.13E+02	1.19E+00	1.41E-07	5.82E+00	2.11E-04	3.53E+00	4.13E-06	1.73E+01	6.27E-03	1.93E+00	2.15E-06	9.82E+00	3.46E-03
241-C-106	3.14E+00	6.18E+01	4.57E-01	5.41E-08	2.53E+01	9.16E-04	8.36E-02	9.77E-08	1.65E+00	5.98E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-107	3.79E+01	9.30E+02	4.11E-01	4.86E-08	1.01E+01	3.66E-04	5.30E-01	6.19E-07	1.30E+01	4.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-108	6.19E+00	2.32E+02	2.52E-01	2.98E-08	9.47E+00	3.43E-04	2.01E-01	2.35E-07	7.54E+00	2.74E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-109	3.23E+01	1.18E+02	1.37E+00	1.62E-07	5.02E+00	1.82E-04	8.18E-01	9.55E-07	2.98E+00	1.08E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-110	3.18E+01	4.20E+02	4.84E-01	5.73E-08	6.38E+00	2.31E-04	7.90E-01	9.24E-07	1.04E+01	3.80E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-111	2.70E+00	8.52E+01	1.27E-01	1.50E-08	4.00E+00	1.45E-04	6.30E-02	7.36E-08	1.99E+00	7.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-112	6.11E+01	1.39E+02	1.59E+00	1.88E-07	3.61E+00	1.31E-04	1.28E+00	1.50E-06	2.93E+00	1.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-201	1.41E-02	2.29E+00	2.99E-03	3.54E-10	4.86E-01	1.76E-05	1.41E-04	1.65E-10	2.29E-02	8.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-202	1.47E-02	2.39E+00	3.12E-03	3.69E-10	5.08E-01	1.84E-05	1.47E-04	1.72E-10	2.39E-02	8.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-203	2.82E-02	4.57E+00	2.40E-03	2.84E-10	3.88E-01	1.40E-05	9.39E-05	1.10E-10	1.52E-02	5.53E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-204	1.81E-02	2.95E+00	1.54E-03	1.82E-10	2.51E-01	9.09E-06	6.06E-05	7.08E-11	9.84E-03	3.58E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	3.30E+02	5.30E+03	1.06E+01	1.25E-06	1.36E+02	4.92E-03	2.11E+01	2.47E-05	2.13E+02	7.74E-02	1.93E+00	2.15E-06	9.82E+00	3.46E-03

Ci = curies.
Cr (VI) = hexavalent chromium.
HI = hazard index.
ILCR = incremental lifetime cancer risk.
kg = kilograms.
Tc-99 = technetium-99.

Table 9. C Tank Farm Risk Evaluation Results for Residential Scenario

Tank	Current Inventory		Residual Waste (360 ft^3 [2,700 gal] C-100 Tanks, 30 ft^3 [220 gal] C-200 Tanks)				Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak				Measured Contamination in C Tank Farm Vadose Zone			
	Tc-99 (Ci)	Cr (VI) (kg)	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI	Tc-99 (Ci)	ILCR	Cr (VI) (kg)	HI
241-C-101	6.97E-01	2.99E+02	2.13E-02	6.14E-08	9.15E+00	1.84E-03	8.66E-03	2.46E-07	3.72E+00	7.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-102	1.32E+00	7.35E+02	1.13E-02	3.26E-08	6.26E+00	1.26E-03	9.96E-03	2.83E-07	5.54E+00	1.12E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-103	1.34E+01	3.91E+02	7.02E-01	2.02E-06	3.33E+00	6.71E-04	2.08E+00	5.92E-05	9.88E+00	1.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-104	5.80E+01	1.46E+03	3.95E+00	1.14E-05	4.59E+01	9.23E-03	1.17E+01	3.33E-04	1.36E+02	2.75E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-105	8.14E+01	4.13E+02	1.19E+00	3.44E-06	5.82E+00	1.17E-03	3.53E+00	1.01E-04	1.73E+01	3.48E-02	1.93E+00	5.24E-05	9.82E+00	1.92E-02
241-C-106	3.14E+00	6.18E+01	4.57E-01	1.32E-06	2.53E+01	5.09E-03	8.36E-02	2.38E-06	1.65E+00	3.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-107	3.79E+01	9.30E+02	4.11E-01	1.18E-06	1.01E+01	2.03E-03	5.30E-01	1.51E-05	1.30E+01	2.62E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-108	6.19E+00	2.32E+02	2.52E-01	7.26E-07	9.47E+00	1.91E-03	2.01E-01	5.72E-06	7.54E+00	1.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-109	3.23E+01	1.18E+02	1.37E+00	3.95E-06	5.02E+00	1.01E-03	8.18E-01	2.33E-05	2.98E+00	6.01E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-110	3.18E+01	4.20E+02	4.84E-01	1.39E-06	6.38E+00	1.28E-03	7.90E-01	2.25E-05	1.04E+01	2.11E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-111	2.70E+00	8.52E+01	1.27E-01	3.66E-07	4.00E+00	8.05E-04	6.30E-02	1.79E-06	1.99E+00	4.02E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-112	6.11E+01	1.39E+02	1.59E+00	4.58E-06	3.61E+00	7.26E-04	1.28E+00	3.65E-05	2.93E+00	5.91E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-201	1.41E-02	2.29E+00	2.99E-03	8.62E-09	4.86E-01	9.78E-05	1.41E-04	4.02E-09	2.29E-02	4.62E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-202	1.47E-02	2.39E+00	3.12E-03	8.99E-09	5.08E-01	1.02E-04	1.47E-04	4.19E-09	2.39E-02	4.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-203	2.82E-02	4.57E+00	2.40E-03	6.92E-09	3.88E-01	7.81E-05	9.39E-05	2.67E-09	1.52E-02	3.07E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
241-C-204	1.81E-02	2.95E+00	1.54E-03	4.44E-09	2.51E-01	5.05E-05	6.06E-05	1.72E-09	9.84E-03	1.99E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	3.30E+02	5.30E+03	1.06E+01	3.05E-05	1.36E+02	2.74E-02	2.11E+01	6.01E-04	2.13E+02	4.30E-01	1.93E+00	5.24E-05	9.82E+00	1.92E-02

Ci = curies.
Cr (VI) = hexavalent chromium.
HI = hazard index.
ILCR = incremental lifetime cancer risk.
kg = kilograms.
Tc-99 = technetium-99.

Tables 8 and 9 show tank farm total ILCR and HI values for each source term but do not show a composite of the source terms because of the separation in arrival time of the source term peaks. As discussed in Section 2.1.3, the peak groundwater concentrations from the residual waste source term would arrive approximately 3,500 years after closure and would not be additive with the peaks from the retrieval leak or past leak source terms. Peak groundwater concentrations from the retrieval leak and past leak source terms would arrive within approximately the next 100 years and would be additive. The cumulative effects of residual waste, past leaks, and potential retrieval leaks in waste management area C are fully analyzed and described in RPP-13774.

The technetium-99 and hexavalent chromium inventories shown in Tables 8 and 9 for the C-100-series tanks other than tanks C-103, C-104, and C-105 were developed using the same approach used for the C-200-series tanks (Section 2.1.2) and are consistent with the inventories used in RPP-13774. The inventories shown for tanks C-103, C-104, and C-105 differ from the inventories used in RPP-13774 and are consistent with the inventories used for the risk analysis presented in *C-100-Series Tanks Waste Retrieval Functions and Requirements* (RPP-18811). The tanks C-103, C-104, and C-105 inventories used in RPP-18811 differ from the inventories used in RPP-13774 because the RPP-18811 analysis assumed that waste would be retrieved from these three tanks using recirculated DST supernate. The calculation method for the tanks C-103, C-104, and C-105 inventories shown in Tables 8 and 9 is summarized in RPP-20589 and described in detail in *Tanks C-103 and C-105 Long-Term Human Health Risk Calculations* (RPP-19071) and *Tank C-104 Long-Term Human Health Risk Calculations* (RPP-20079).

The residual waste inventories shown in Tables 8 and 9 for the C-100-series tanks were based on residual volumes of 360 cubic feet, corresponding to the HFFACO Milestone M-45 interim retrieval goal for 100-series SSTs. The retrieval leak inventories shown for the C-100-series tanks were based on a hypothetical retrieval leak volume of 8,000 gallons. This volume was used for informational purposes to provide a point of reference on the graphs and is not intended to represent anticipated retrieval leak volumes or leak detection limits for the C-100-series tanks.

The past leak inventory shown in Tables 8 and 9 is consistent with the inventory used in RPP-13774. As discussed in Section 2.1.2, this inventory reflects the fact that the preponderance of currently available data supports the recognition of one pre-existing source of vadose zone contamination (past leak) in the vicinity of tank C-105. Further discussion of C tank farm vadose zone contamination is provided in RPP-13774 and DOE/ORP-2003-02.

As shown in Tables 8 and 9, the retrieval leakage technetium-99 ILCR is approximately an order of magnitude greater than the ILCR from residual waste for the C-100-series tanks. For the C-200-series tanks, the retrieval leakage technetium-99 ILCR is slightly less than the ILCR from residual waste. These same relationships hold true for the hexavalent chromium HI values.

Tables 8 and 9 indicate that the tank farm total technetium-99 ILCR from residual waste is approximately 1×10^{-6} and 3×10^{-5} for the industrial and residential scenarios, respectively. The tank farm total technetium-99 ILCR from retrieval leaks is approximately 2×10^{-5} and 6×10^{-4} for the industrial and residential scenarios, respectively. The tank farm total technetium-99 ILCR from past leaks is approximately 2×10^{-6} and 5×10^{-5} for the industrial and residential scenarios, respectively.

Tables 8 and 9 indicate that the tank farm total hexavalent chromium HI from residual waste is approximately 5×10^{-3} and 3×10^{-2} for the industrial and residential scenarios, respectively. The tank farm total hexavalent chromium HI from retrieval leakage is approximately 8×10^{-2} and 4×10^{-1} for the industrial and residential scenarios, respectively. The tank farm total hexavalent chromium from past leaks is approximately 3×10^{-3} and 2×10^{-2} for the industrial and residential scenarios, respectively.

2.3 INTRUDER RISK

An analysis of inadvertent human intrusion impacts for waste management area C is provided in *Preliminary Performance Assessment for Waste Management Area C at the Hanford Site, Washington* (DOE/ORP-2003-11). That report used exposure scenarios defined in HNF-SD-WM-TI-707 and was based on intruder analyses presented in earlier Hanford Site performance assessments (*Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds* [WHC-EP-0645], *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds* [WHC-EP-0875], *Hanford Immobilized Low-Activity Tank Waste Performance Assessment* [DOE/RL-97-69], *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* [DOE/ORP-2000-24]).

The C-200-series tanks analysis results reported in DOE/ORP-2003-11 are summarized in this section to provide additional perspective on potential post-closure risks associated with the C-200-series tanks assuming waste is retrieved to the HFFACO interim retrieval goal.

2.3.1 Intruder Scenarios and Performance Objectives

The DOE/ORP-2003-11 analysis included several scenarios, all of which assumed that no memory of the closed facility remains following closure. The credible post-closure intrusion scenarios identified were as follows:

- An inadvertent intruder who drills into the closed site and brings some of the waste to the surface receiving an acute dose (driller scenario).
- A post-drilling resident who lives where waste has been exhumed and scattered over the surface (post-intrusion residential scenarios). Three residential scenarios were included:
  - Suburban resident with a garden
  - Rural farmer with a diary cow
  - Commercial farmer.

Detailed descriptions of the scenarios are presented in DOE/ORP-2003-11 and HNF-SD-WM-TI-707. The basement scenario was not considered credible in DOE/ORP-2003-11 and was not analyzed.
The performance objective for the driller scenario was 500 mrem effective dose equivalent for a one-time exposure. The performance objective for the post-intrusion residential scenarios was 100 mrem/yr effective dose equivalent for a continuous exposure. The time of compliance for the DOE/ORP-2003-11 analysis was 500 years after closure and closure was assumed to occur in the year 2050.

2.3.2 Results

Table 10 summarizes the DOE/ORP-2003-11 analysis results for the C-200-series tanks. The values in the table give the estimated tank-specific impacts for each scenario from intrusion at 500 years after closure assuming each tank contains a volume of 30 cubic feet of residual waste at closure. The residual waste contaminant inventories used for the analysis were consistent with the Selected Phase Removal data set from DOE/ORP-2003-02.

Table 10. C-200-Series Tanks Intruder Dose

Tank	Driller (mrem) EDE	Suburban Resident with a Garden (mrem/yr) EDE	Rural Farmer with a Diary Cow (mrem/yr) EDE	Commercial Farmer (mrem/yr) EDE
C-201	1.46	22.1	0.39	0.004
C-202	0.77	11.5	0.20	0.002
C-203	0.16	2.3	0.04	0.000
C-204	0.005	0.06	0.001	0.000

Source: DOE/ORP-2003-11, Appendix C.
EDE = effective dose equivalent.

Table 10 indicates that none of the C-200-series tanks would exceed the performance objectives at 500 years after closure. Tank C-201 would have the highest impacts. The most significant contributors to the dose at 500 years were plutonium-239, plutonium-240, and americium-241.

3.0 FUNCTIONS AND REQUIREMENTS

This document establishes the upper-level functions and corresponding requirements to which the C-200-series tanks WRS must be designed and operated. Other requirements not directly applicable to the level of definition provided in this document are disseminated to CH2M HILL Hanford Group, Inc. via the DOE-CH2M HILL Hanford Group, Inc. Contract (Contract DE-AC-27-99RL14047). Specifically, the F&R included in this document are derived from the need to satisfy the HFFACO Milestone M-45-00 requirements to retrieve as much tank waste as technically possible, with tank waste residues not to exceed 30 cubic feet, or the limit of the waste retrieval technology, whichever is less. Additionally, the F&R ensure that waste retrieval actions do not result in adverse impacts to workers, the public, or the environment. Some of these requirements are derived from the regulatory documents, such as the *Code of Federal Regulations* and the *Washington Administrative Code*, while others are based on the design limitations of the C-200-series tanks and the DST receiver tank. The F&R are provided in Table 11 and are focused on appropriately driving the design of the C-200-series WRS so that the aforementioned requirements are met. These F&R are consistent with RPP-14075.

Table 11. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
Control structure and waste temperature in C-200-series tanks	Maintain tank structure and waste temperature within limits defined in SST operating specification.	OSD-T-151-00013	Maximum 137 °C (280 °F) for waste and maximum 120 °C (250 °F) for dome
Control C-200-series tank waste level	Prevent waste overflow and limit hydrostatic head-induced stresses in the tank.	OSD-T-151-00013	Maintain waste level from exceeding 280 in. and minimize liquid level to the extent practical
Control vapor space pressure in the C-200-series tanks	Maintain vapor space pressure within limits defined in SST operating specification.	OSD-T-151-00013	Minimum as required by OSD-T-151-00013, latest revision.
Control gaseous discharges from the C-200-series tanks	The ventilation system exhaust shall be filtered to restrict emissions to the environment.	WAC 173-400 WAC 173-460 WAC 246-247 HNF-IP-0842, Volume 6, Section 1.7	Mitigate potential release to the public, and the environment
Remove waste from the C-200-series tanks	The C-200-series WRS shall be capable of removing as much waste as technically possible, with tank waste residues not to exceed 30 ft^3, or the limit of the waste retrieval technology, whichever is less. If DOE believes that waste retrieval to these levels is not possible for a tank, DOE will submit a detailed explanation to EPA and Ecology explaining why these levels cannot be achieved, and specifying the quantities of waste that DOE proposes to leave in the tank. The request will be approved or disapproved by EPA and Ecology on a case-by-case basis.	HFFACO Milestone M-45-00	The WRS shall provide the ability to retrieve waste to less than 30 ft^3
Control and monitor the waste removal process in the C-200-series tanks	The C-200-series WRS shall provide the monitor and control capability to control the waste retrieval and transfer process. This includes controlling and monitoring the following C-200-series WRS process parameters: • Pressures • Flow rates • Differential pressures across exhaust ventilation filters • Leak detection systems. The C-200-series WRS shall be operated remotely, have video monitoring capabilities, and provide instrumentation to support performing material balance calculations.	RPP-13033 HNF-SD-WM-TSR-006 WAC 173-303	Provide for safe and effective operation of the WRS

Table 11. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
Detect leaks during waste removal from the C-200-series tanks	The WRS shall be capable of detecting liquid waste releases during all waste removal operations. The system shall be designed to detect leakage from the tank using technologies consistent with waste retrieval methods to detect tank leaks during retrieval.	WAC 173-303 HNF-SD-WM-TSR-006	Utilize LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage; see Section 4.0
Monitor leaks from the C-200-series tanks during waste removal	The WRS shall quantify liquid release volumes from the C-200-series tanks if a release is detected during waste retrieval operations.	WAC 173-303	Utilize LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage
Measure and estimate residual waste in the C-200-series tanks	The WRS design shall allow for estimating the residual waste in the C-200-series tanks following retrieval operations.	HFFACO, Appendix H	Design feature. Residual volume will be estimated using in-tank video. Requirements for post-retrieval waste volume measurement will be documented in RPP-16616.
Minimize waste generation	The WRS shall minimize waste generation to the greatest extent practical, including water introduced into the tank.	WAC 173-303	No numerical requirement
Mitigate leaks during the C-200-series waste retrieval	The integrated retrieval and LDM system shall be designed and operated to mitigate leaks as the primary means of minimizing environmental impacts from leaks during retrieval if they occur. The primary means of mitigation shall be through removal of free liquid as rapidly as feasible using the equipment described in this document.	HNF-SD-WM-AP-005 WAC 173-303	Leak mitigation strategy described in Section 4.0
Mitigate potential for leaks to occur during the C-200-series waste retrieval	Prevent inadvertent release from a C-200-series tank to the environment.	RPP-13033, Section 3.3.2.3.4	Do not raise waste level above "benchmark" level. "Benchmark" level to be provided in Process Control Plan
Nuclear safety	The WRS shall be designed and operated to protect workers, public, the environment, and equipment from exposure to radioactive tank waste and emissions during the retrieval campaign.	WAC 246-247 10 CFR 830 RPP-13033 HNF-SD-WM-TSR-006 HNF-IP-1266	Ensure protection of workers and the public from routine and potential accident conditions
Maintain design and operating limits for DST used as a	The WRS shall not adversely affect the function of the DST system or exceed the DST design and	HNF-SD-WM-TRD-007	Ensure safe and effective receipt and storage of the C-200-series tank waste

Table 11. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
receiver tank	operational limits.		in receiver DST
Occupational safety and health	The C-200-series WRS shall be designed for safe installation, operation & maintenance. Prevent undue exposure of personnel to dangerous waste and prevent releases to the atmosphere.	29 CFR 1910 10 CFR 835 29 CFR 1926	OSHA standards Personnel protection and release prevention controlled by compliance with Tank Farm Health and Safety Plan.
SST and DST dome loading	The WRS shall not exceed the maximum dome loading on existing SSTs and DSTs specified in HNF-SD-WM-SAR-067.	HNF-IP-1266 RPP-13033 HNF-SD-WM-TSR-006 TFC-ENG-FACSUP-C-10	Mitigates possible structural failure of tank dome
WRS secondary containment and leak detection	For ex-tank equipment and piping, the WRS shall incorporate secondary containment and leak-detection design features in accordance with 40 CFR 265.193, WAC 173-303-640(4), and DOE O 435.1.	40 CFR 265 WAC 173-303 DOE O 435.1 RPP-13033 HNF-SD-WM-TSR-006	Provide for safe and compliant transfer of waste to the receiver DST

CAM = continuous air monitor.
DOE = U.S. Department of Energy.
DST = double-shell tank.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
HFFACO = *Hanford Federal Facility Agreement and Consent Order.*
LCO = Limiting Condition for Operation.
LDM = leak detection and monitoring.
OSHA = Occupational Safety and Health Administration.
SST = single-shell tank.
WRS = waste retrieval system.

4.0 DESCRIPTION OF PLANNED LEAK DETECTION AND MONITORING TECHNOLOGY, AND OPERATING STRATEGY

4.1 EXISTING MONITORING

This section describes tank leak monitoring activities that are currently being performed.

4.1.1 Drywell Monitoring

Figure 4 shows the drywells around the C farm tanks. There are a number of drywells surrounding the 100-series tanks within the C farm; however, there are no drywells surrounding the 200-series tanks. Therefore, there are no ongoing routine C-200-series tanks drywell monitoring activities.

4.1.2 Groundwater Monitoring Wells

Figure 5 provides a plan view of the C tank farm and the surrounding *Resource Conservation and Recovery Act of 1976* (RCRA) groundwater monitoring wells. The wells are 299-E-27-4, 299-E-27-7, 299-E-27-12, 299-E-27-13, 299-E-27-14, 299-E-27-15, 299-E-27-21, 299-E-27-22, and 299-E-27-23.

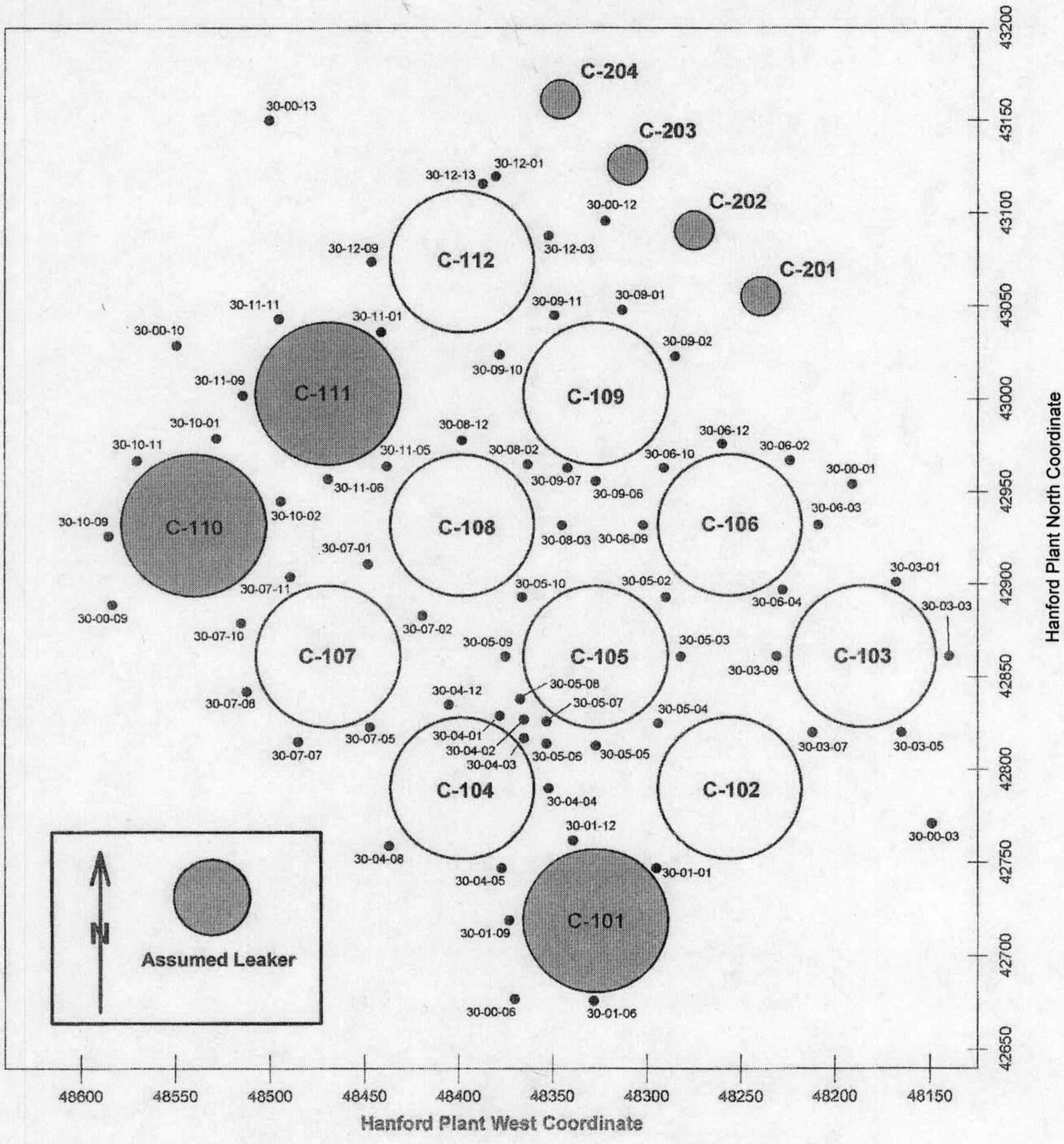
4.1.2.1 Use of Existing Groundwater Monitoring Wells for C-200 Retrieval Process Control

The nearest groundwater monitoring well is 299-E27-7 located approximately 90 feet northeast of the nearest C-200-series tank, tank C-201. The C-200 series tank with the largest volume of waste, tank C-203, is located approximately 165 feet west of well 299-E-27-7 and 170 feet south of well 299-E-27-22. Groundwater monitoring wells in the vicinity of the C-200-series tanks are located too far from any tank to be of use for process control during the time durations planned for waste retrieval.

4.1.2.2 Sampling of Groundwater Monitoring Wells for C-200-Series Tank Waste Retrieval

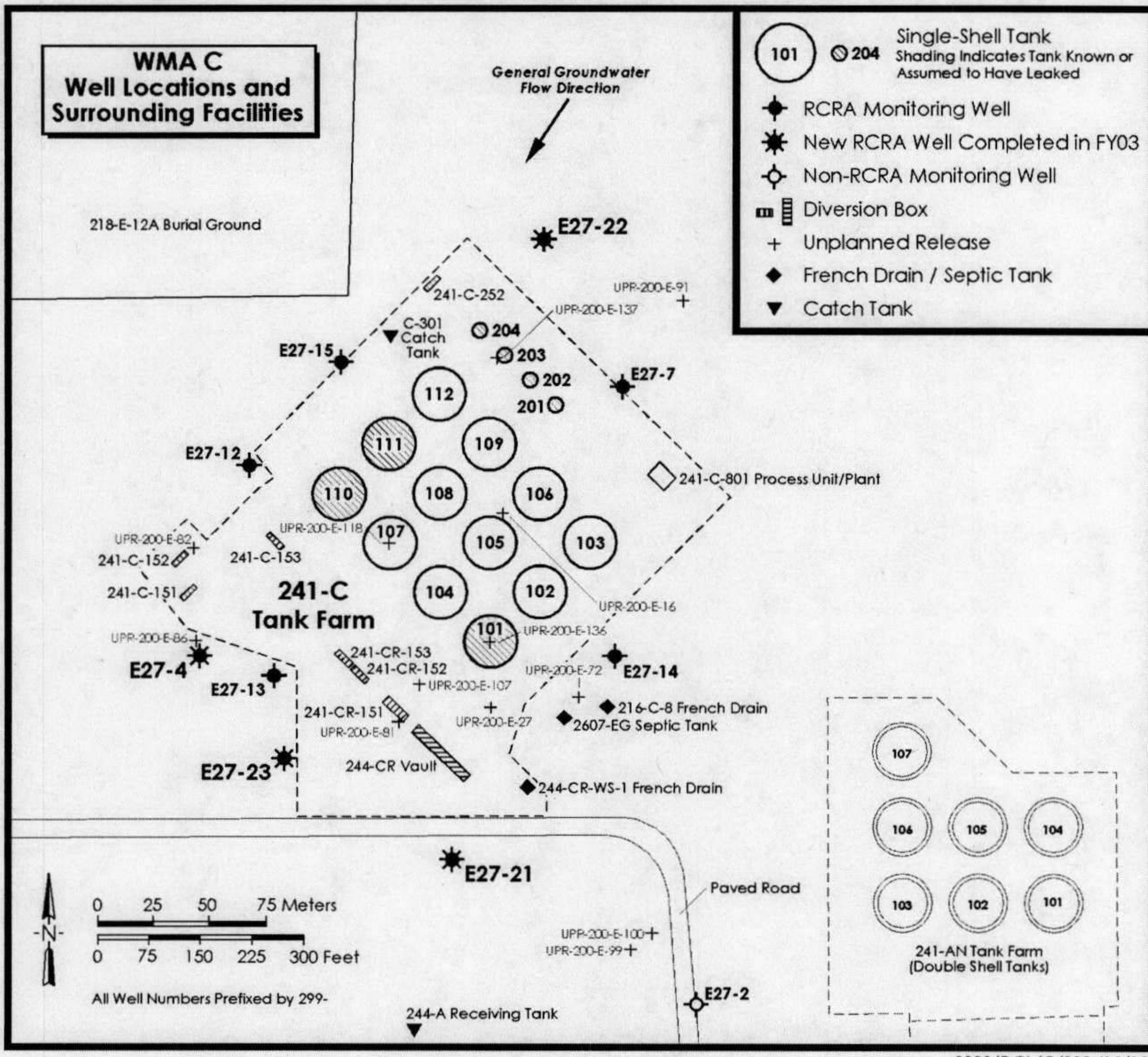
Groundwater monitoring activities are consistent with the current *RCRA Groundwater Monitoring Plan for Single-Shell Tank Waste Management Area C at the Hanford Site* (PNNL-13024) and coordinated with other environmental monitoring as appropriate.
Since June 2002, sampling for the groundwater wells 299-E-27-7, 299-E-27-12, 299-E-27-13, 299-E-27-14, 299-E-27-15 has been performed on a quarterly basis per request by Ecology. Since December 2003, new groundwater monitoring wells 299-E-27-4, 299-E-27-21, 299-E-27-22, and 299-E-27-23 have also been sampled on a quarterly basis. Groundwater samples will be taken within 60 days prior to starting waste retrieval from the first tank and following completion of waste retrieval field operations from the last tank. Per request from Ecology in August 2004, quarterly samples are analyzed as a minimum for anions, cyanide, ICP metals, gross beta, technetium, and a low-level gamma scan. Data collected from groundwater monitoring could be used for future closure activities and decisions.

Figure 4. Plan View of the C Tank Farm Showing Drywells



Source: GJO-HAN-18.

Figure 5. Waste Management Area C and Regulated Structures



2003/DCL/C/008 (12/15)

4.1.3 Existing Level Measurement Instrumentation

4.1.3.1 C-200 Series Tanks to Be Retrieved

There were manual tape waste level measurement devices on tanks C-201, C-202 and C-204, but these have been removed as part of the retrieval equipment installation process. An Enraf level gauge is currently installed on tank C-203 and will remain in place until retrieval is completed for this tank. Following retrieval of waste from tank C-203, an Enraf gauge will be installed on tank C-202. This Enraf gauge will remain in place on tank C-202 during the retrieval of waste from tanks C-202, C-201, C-204, and subsequent removal of drain water added to tank C-202 during the tanks C-201 and C-204 waste retrievals.

4.1.3.2 Receiving Tank

Leak detection for the receiving tank, AN-106, is the annulus leak detection currently employed and described in Section 4.0 of *Operating Specifications For Tank Farm Leak Detection And Single-Shell Tank Intrusion Detection* (OSD-T-151-00031), and consists of three annulus leak detector probes and one primary tank level instrument.

4.2 PROPOSED LEAK DETECTION AND MONITORING SYSTEM DESCRIPTION

4.2.1 Proposed Leak Detection and Monitoring System to be Used During Waste Retrieval

4.2.1.1 Proposed Leak Detection Monitoring for Tanks C-203, C-202, C-201, and C-204 Waste During Retrieval

The planned LDM for each C-200 series tank undergoing waste retrieval is:

- Following retrieval of waste from a tank, a mass balance will be performed around the tank. A report shall be issued providing the results and supporting documentation for a waste unaccounted for (WUF) calculation using Equation 4-1 (or similar equation) for each C-200-series tank retrieved. Should the WUF be within the limit of error for the measurement process, there will be no further documentation required beyond the WUF report. Should the WUF be greater than the limit of error, the response will be as described in Section 4.6.1.

$$WUF = [(1 - \theta_s) \times (V_{C\text{-}200s}) - (1 - \theta_e) \times (V_{C\text{-}200e})] + \Delta V_{water} - \Delta V_{evap} - \Delta V_{AN\text{-}106} \pm \Delta V_{oth} - LE \qquad \text{Eq. 4-1}$$

Where:

θ_s = waste porosity at start of retrieval

θ_e = waste porosity at end of retrieval

$V_{C\text{-}200s}$ = best estimate of starting waste volume

$V_{C\text{-}200e}$ = best estimate of ending waste volume

ΔV_{water} = volume of water in C-200 retrieval equipment at start + volume of water added to C-200 water skid + estimate of volume of skid HVAC condensate and exhauster seal pot condensate added [for tanks C-203 and C-202 retrieval only] - volume of water in C-200 retrieval equipment at end

ΔV_{evap} = estimated volume of water vapor removed from the tanks due to evaporation

$\Delta V_{AN\text{-}106}$ = change in volume of AN-106 due to additions from C-200 transfer line

ΔV_{oth} = this covers all other volume changes such as additions to drains or drain water to tank C-202 during tanks C-201 and C-204 retrieval

LE = limit of error associated with porosity, C-200 volume measurements, water volume measurements and AN-106 volume measurements

- During waste retrieval operations, limited leak detection capability will be provided by periodic mass balances performed for process control purposes. These will compare water volume added to the WRS with the volume of waste and water removed from the tank. No retrieval tank waste volume measurement will be available during retrieval except for the visual image provided by the TV camera employed during active operations. A waste surface reading could be taken for tanks C-203 and C-202 during extended down times, should waste retrieval be temporarily suspended. Without a waste surface measurement the usefulness of a mass balance for leak detection during retrieval is limited to spotting significant leaks only, and then only under limited conditions.

Figure 6 is a sketch of the C-200-series waste retrieval process showing where water is used, the planned measurement locations, and the data obtained at each.

4.2.1.2 Leak Detection Monitoring for Tank C-202 During Receipt of Drain Water From Retrieval of Tanks C-201 and C-204

Figure 7 is a simplified sketch showing the drain water streams associated with the vacuum retrieval process. The planned LDM for tank C-202 when receiving drain water from retrieval activities in tanks C-201 and C-204 is:

- During the time tank C-202 is used to store tank C-201/C-204 related drain water, should sufficient liquid be added to tank C-202 to provide a liquid surface and the liquid level reach approximately 1,100 gallons, leak detection would be performed using the Enraf gauge. Below approximately 1,100 gallons, there is insufficient material in the tank to float the Enraf gauge plummet, so leak detection is not practical.

Figure 6. C-200-Series Flow Diagram and Volume Measurement Locations

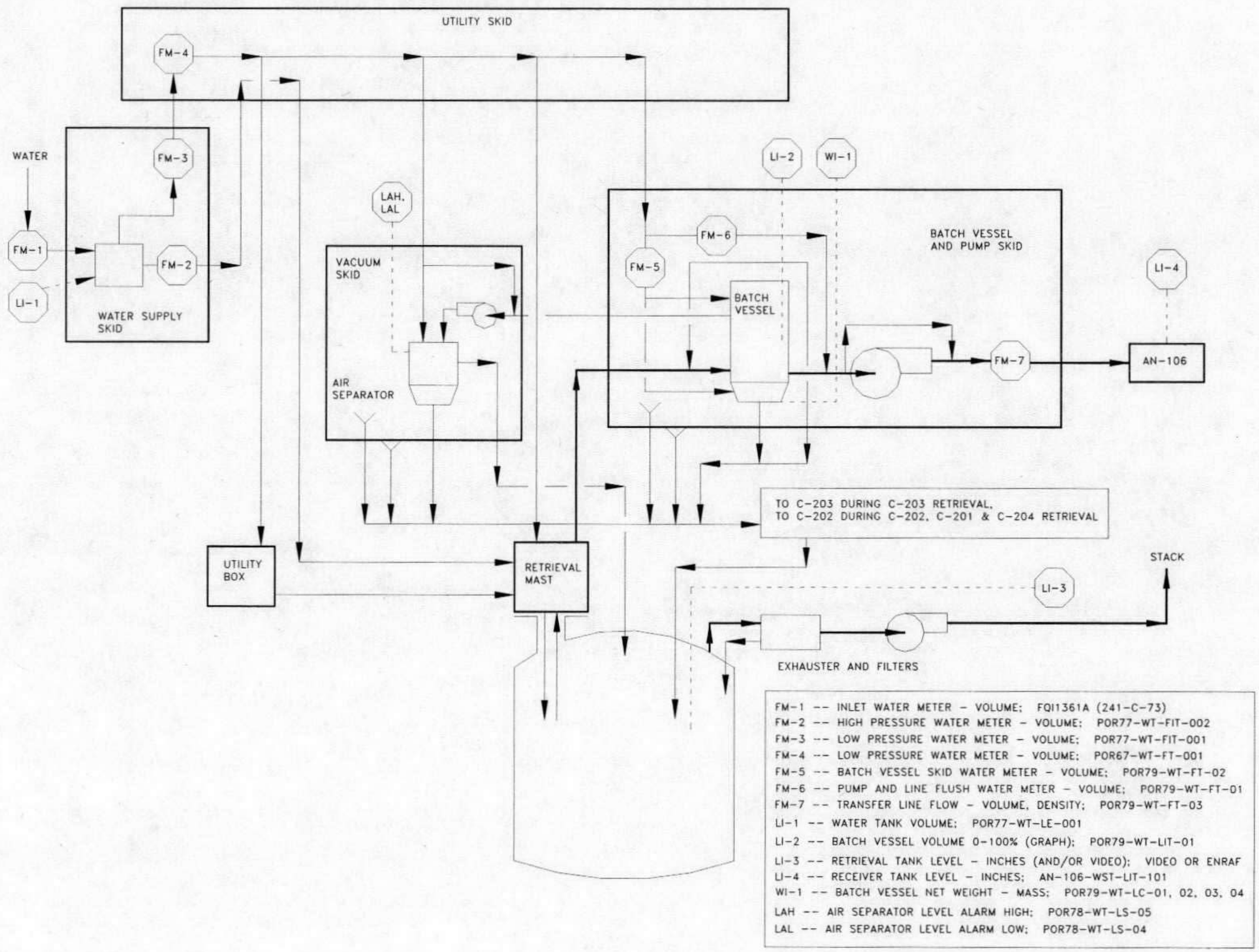
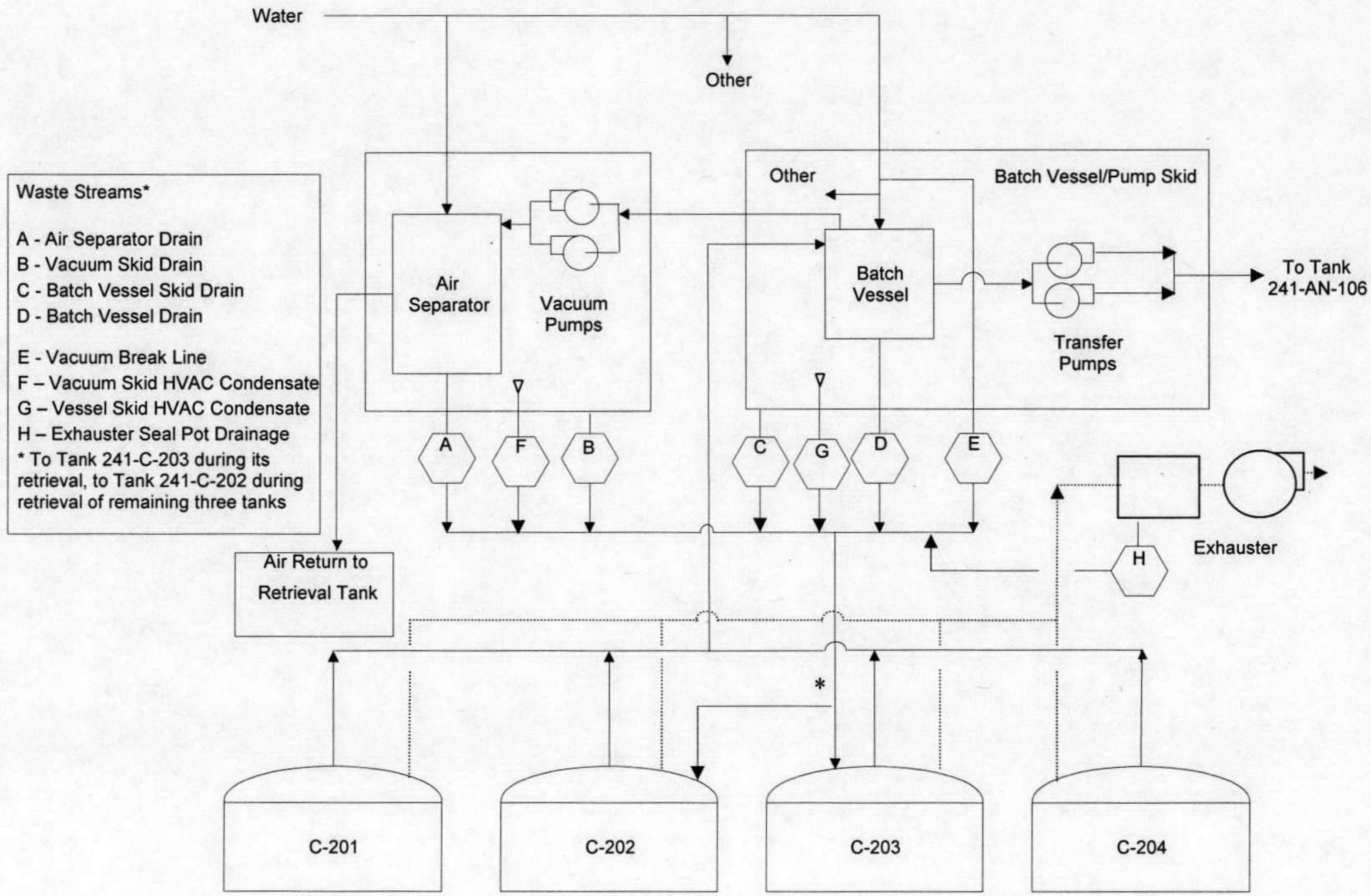


Figure 7. Drain Water Sources



4.2.1.3 Leak Detection Monitoring for Aboveground Equipment Skids

There are two aboveground equipment skids which will contain waste or drain water solutions. These are the batch vessel skid which contains the batch vessel and associated transfer pumps, and the vacuum skid which contains the vacuum blowers and air separator vessel. The planned LDM for these aboveground equipment skids is:

- Each skid shall have a sealed containment floor with a drain. This drain will be routed back to tank C-203 during tank C-203 waste retrieval and to tank C-202 during retrieval of waste from tanks C-202, C-201 and C-204. This line will contain leak detectors which will activate in the event liquid is detected in the drain line and shut down any waste transfers.

- Each skid will also have internal video capability. If operable, these can be used to help determine the source of a detected leak.

4.2.1.4 Leak Detection Monitoring for AN-106 Receiving Tank

The existing tank AN-106 leak detection system shall be used. There are no changes required to support C-200-series tank waste retrieval.

4.2.1.5 Leak Detection Monitoring for Waste Transfer Lines

Leak detection will be provided during C-200-series tank waste retrieval for transfer line leaks using the standard leak detection methods described in the Documented Safety Analysis (DSA), Section 4.4.7, currently employed for all waste transfers within tank farms.

4.2.2 Proposed Use of Existing Drywells and Groundwater Monitoring Wells During and After Waste Retrieval

Because there are no drywells around the C-200-series tanks there will be no drywell monitoring during or after waste retrieval as discussed in Sections 4.1.1 and 4.3.1.2. Groundwater monitoring wells will be sampled during and after C-200-series tank waste retrieval as discussed in Section 4.1.2.2.

4.3 RATIONALE FOR SELECTION OF LEAK DETECTION AND MONITORING TECHNOLOGY

The following excerpt concerning SST leak detection is from "S-112 Full Scale Leak Detection, Mitigation, and Monitoring (LDMM) Hanford Federal Facility Agreement and Consent Order (HFFACO) Milestone M-45-03C; S-112/C-104 Functions and Requirements (F&R) Conditional Approval Letter HFFACO Milestones M-45-03-T03 and M-45-03-T04); and S-102 Functions and Requirements (F&R) LDMM Comments/Responses, HFFACO Milestone M-45-05-T16" (Lyon 2003):

For tanks where at least several thousand gallons of liquid are being added during retrieval and/or tanks containing at least several thousand gallons of liquid waste prior to retrieval, LDMM objectives must include but are not limited to the following:

1) *The leak detection system should be capable of detecting relatively small leaks (2,000 gallons or less) with at least a 95% probability of detection and a maximum 5% probability of positive false alarms.*
2) *Leaks are to be detected in a timely manner; i.e., within 24 hours of the escape of liquids from containment*
3) *Leak volumes and leak rates must be reasonably calculated to the extent possible, in a timely manner—prefer a determination within 48 hours following confirmation of a leak.*
4) *Data can be rapidly reduced to provide results allowing for timely retrieval/closure action decision by site owners/operators and regulators.*
5) *Leak detection and monitoring systems should interrogate the entire environment surrounding an SST (not simply selected sample points) and should have the potential to assess impacts from a leak within the operating system.*
6) *Leak detection and monitoring should track the lateral and vertical movement of any leak within the above criteria.*
7) *Leak detection methods should be based on the best available technology applicable to the tank waste type and retrieval method.*

As discussed in Section 1.3, the C-200-series tanks contain 800 to 2,600 gallons of solids. RPP-14627, Table 2-1, states the tanks contain 5 to 42 weight percent estimated water contents. Therefore, none of the C-200-series tanks contain "...at least several thousand gallons of liquid waste..." stated as a precursor for meeting the seven LDMM objectives.

The estimated liquid additions to the C-200-series tanks during waste retrieval are provided in Section 4.7.2.4. While the volume of water added to a tank during waste retrieval may exceed the value of "...at least several thousand gallons of liquid are being added..." (Lyon 2003) for at least one of the four C-200-series tanks, this is over an extended period of time. Regardless of the total quantity of liquid added to a tank during the waste retrieval process, the volume of free liquid in a tank at any time is kept to the minimum practical. See Section 4.8.1 for a discussion of the maximum free liquid volume expected to be in a tank being retrieved.

The primary function of a leak detection method for deployment during waste retrieval activities is for process control (i.e., to provide information that will enable a response to reduce the leak size). If a leak detection system will provide little leak volume minimization capability, or equivalent leak volume minimization can be provided by more timely and cost effective means, any provision for new LDMM equipment for a specific waste retrieval must be evaluated and justified.

For the C-200-series tank waste retrievals leak minimization is provided by actions taken during waste retrieval, as described in Section 4.6.1. These actions result in there being no additional leak volume size reduction benefit provided by new leak detection equipment for C-200-series tank waste retrieval.

4.3.1 Rationale for Leak Detection and Monitoring Selected, and Not Selected, for C-200-Series Waste Retrieval Tanks

4.3.1.1 Rationale for Leak Detection and Monitoring Selected for C-200-Series Waste Retrieval Tanks

The requirements for SST LDM for tanks in a waste storage mode are provided in *Single-Shell Tank System Leak Detection and Monitoring Functions and Requirements* (RPP-9937). RPP-9937 is an approved TPA Primary Document.

Per RPP-9937 Revision 0B (Executive Summary and Section 1.2), monitoring requirements for tanks undergoing waste retrieval are beyond the scope of RPP-9937. The four C-200-series tanks have been in a waste retrieval mode since June 2004. The leak detection requirements for the C-200-series tanks for a retrieval mode are specified in this F&R document. A mass balance following retrieval of a tank was selected as the LDM method because it is the only one currently available for the C-200-series tanks and there is no additional benefit in leak volume reduction potential provided with any available or proposed alternate means of tank leak detection besides the leak potential minimization guidelines in Section 4.6.1. While only a gross mass balance is possible during retrieval, a mass balance performed around the system when retrieval is completed can indicate whether any material has been lost outside the limit of error of the data used.

The following wording is intended to show there is minimal additional potential for a leak to occur during vacuum waste retrieval of the C-200-series tanks over the potential for a leak to occur during waste storage, providing the guidelines in Section 4.6.1 are followed.

Waste retrieval activities for the C-200-series tanks could increase the tank leak potential over the leak potential during storage if:

- There is a leak path in the tank wall or bottom below the waste surface, and water added to the tank during waste retrieval results in leakage out this hole, or
- There is a leak path in the tank wall above the current liquid level and water added to the tank increases the liquid level above this point, or
- There is a corroded and weakened, but currently sound, location on the tank wall that is penetrated by a water spray stream directed at the spot, or
- There is a corroded and weakened, but currently sound, location on the tank wall or bottom that is penetrated by the articulated mast system (AMS) during installation, or
- There is a corroded and weakened, but currently sound, location on the tank bottom that is penetrated by the AMS during waste retrieval, or
- There is a waste material plugging an existing hole in the tank wall or bottom, and this material is either dissolved up or dislocated by a water stream during waste retrieval.

Per *Updated Pumpable Liquid Volume Estimates & Jet Pump Durations For Interim Stabilization Of Remaining SST* (HNF-2978) experience with saltwell pumping has shown capillary action within saltcake can hold 6 to 24 inches of liquid, while sludge will hold about 24 inches. The waste in the C-200-series tanks is believed to be mostly sludge. Because the waste levels in the four C-200-series tanks range from about 7 to 16 inches, little or no liquid would be expected to drain from a hole under the waste surface because of this capillary retention unless the waste was saturated and there was a liquid pool present above the waste surface.

By performing the following the leak minimization actions (repeated in Section 4.6.1) there is no significant potential increase for a leak to occur during vacuum retrieval of the C-200-series tanks over the potential for a leak to occur during waste storage:

- Limiting the hydraulic pressure provided to the AMS to the minimum practical for effective retrieval operations
- Providing care not to penetrate the tank bottom during AMS installation
- Using a video camera while retrieving
- Minimizing the presence of liquid pools to the extent practical
- Retrieving waste as much as practical from the center of the tank out.

4.3.1.2 Rationale for Leak Detection and Monitoring Not Selected for C-200 Series Retrieval Tanks

The only leak detection alternatives to a mass balance considered for C-200 retrieval were installation of new drywells and installation of high-resolution resistivity (HRR) equipment. Installation of a real-time in-tank video mapping process was not considered as there is no indication such a system would be reliable, or viable, at this time. Other internal tank leak detection methods are not practical during active waste retrieval operating periods because of the variable waste and liquid levels in the tank.

The only external tank leak detection methodology used in the past within tank farms is drywell monitoring (or laterals monitoring in a few tank farms). Drywells are installed around many SSTs, and if there were any around the C-200-series tanks they would be used to provide some leak detection capability in addition to the selected mass balance. Even if drywells were installed, a leak may not be spotted until waste retrieval is complete, and might not be spotted ever depending upon the leak location with respect to the drywells, and the leak size.
There would be no reduction in the size of a leak regardless of whether a leak was spotted or not since leak minimization activities for C-200-series tank waste retrieval are based on steps taken during retrieval, not on steps taken following a leak discovery. Drywells, if present, could help track the path of a leak if detected.

If new leak detection equipment were to be installed it would be preferable to provide HRR, which has the potential to be a valid external tank leak detection system with more sensitivity and area coverage than that provided by drywells. HRR capability for leak detection during waste retrieval will be provided pursuant to Milestone M-45-00B in Change Request M-45-04-01. This milestone commits the Office of River Protection to deploy an electrical resistance leak detection method on the first three 100-series tanks to be retrieved after tank S-112. The HRR equipment is already installed or in the process of being installed for three 100-series tanks now. There are no HFFACO milestone requirements for HRR deployment in the C-200-series tanks.

Providing a HRR LDM system for C-200-series tanks undergoing vacuum retrieval would result in no reduction in the size of leak. Leak minimization activities for C-200-series tank waste retrieval are based on steps taken during waste retrieval, not on steps taken following a leak discovery. If HRR was a proven, reliable, process it could help track the path of a detected leak or provide assurance that waste retrieval was proceeding without a detectable leak.

HRR is an unproven process for leak detection within tank farms. Operational experience gained during retrieval of waste from the three 100-series-tanks (and in a tank S-102 post-retrieval water injection test) will determine its suitability for general use in future retrievals. Per Milestone M-45-00B in Change Request M-45-04-01, the usefulness of HRR will be evaluated following the retrieval in these tanks and a decision made at that time on its future deployment. At this time there is no data to indicate whether HRR will be better or worse than mass balance as a leak detection method for the C-200-series tanks.

4.3.2 Rationale for Leak Detection and Monitoring for Tank C-202 During Receipt and Storage of Tanks C-201 and C-204 Drain Water

Tank C-202 will have already undergone waste retrieval before it is used for receipt of drain water generated during tanks C-201 and C-204 waste retrieval. Should the mass balance performed around this tank following retrieval show no leak volume above the limit of error for the measurement equipment this would indicate the tank's suitability for use as a drain water receipt tank during retrieval of waste from tanks C-201 and C-204. If the tank C-202 mass balance did show a potential leak during retrieval it might not be used for drain water receipt from tanks C-201 and C-204 waste retrieval. In this case, tank C-201 would likely be selected.

Following tank C-202 waste retrieval there will be an expected 0 to 220 gallons of waste present in the tank. Drain water volumes predicted to be added to tank C-202 are provided in Section 4.8.1. Should sufficient liquid be added to tank C-202 during tanks C-201 and C-204 waste retrieval to provide a liquid surface greater than 1,100 gallons, liquid level monitoring will be performed in tank C-202 using the Enraf gauge. Below approximately 1,100 gallons there is insufficient material in the tank to float the Enraf gauge plummet, so in-tank liquid level monitoring is not feasible. There are no readily available alternate risers on the tank located closer to the center which would permit a liquid surface detection device to be employed to detect waste levels below about 1,100 gallons. There is a center pit that is highly contaminated and foamed over for intrusion protection. Removing this covering and cleaning up the pit to the point where a level gauge can be installed for a few days to a few months is not warranted from a cost, schedule, or personnel exposure standpoint.

4.3.3 Rationale for Selected Leak Detection and Monitoring for Aboveground Equipment Skids

The leak detection method chosen for the vacuum and batch vessel equipment skids was selected to meet the requirements in WAC 173-303-640 for leak detection and containment.

4.3.4 Rationale for Selected Leak Detection and Monitoring for AN-106 Receiving Tank

The leak detection method chosen for the receiving tank was selected because it is currently in place and is the approved leak detection for storage specified in OSD-T-151-00031.

4.3.5 Rationale for Selected Leak Detection and Monitoring for Transfer Lines

The leak detection method chosen for the transfer lines was selected as it is the same as currently used within tank farms for other transfers and is compliant with WAC 173-303-640 for leak detection and containment.

4.4 FUNCTIONS AND REQUIREMENTS NECESSARY TO SUPPORT DESIGN OF PROPOSED LEAK DETECTION AND MONITORING SYSTEMS

See Section 3.0 and Table 11.

4.5 ANTICIPATED TECHNOLOGY PERFORMANCE CAPABILITY

4.5.1 Performance of Leak Detection and Monitoring for C-200-Series Waste Retrieval Tanks

The limit of error associated with a specific tank retrieval mass balance cannot be stated in advance as it will vary with each tank and be dependent upon the variation in starting and ending tank waste volume estimates, the quantity of water used for each retrieval (includes water added to the tank for waste mobilization, water to the air separator, water for transfer line dilution and flushes, and sundry other process uses), assumptions as to the waste porosity, leaks to system drains, evaporation rates, condensate volumes, seal pot drainage volumes, water meter accuracy and Enraf accuracy. A rough estimate indicates the post-retrieval limit of error for a mass balance around a C-200-series tank containing a nominal pre-retrieval volume of 2,500 gallons of waste may be in the 1,200- to 5,000-gallon range, but the final limit of error value could be outside this range.

Process control mass balances are performed at least once for each transfer period to compare water usage with waste transferred. The waste transfer material balance period will vary; it may be as short as 4 hours (or less) or it could go for several shifts (16 to 24 hours). A transfer period is described in Section 4.5.2. A number of discrepancies could show up in these process control mass balances. Discrepancies are evaluated when noted and an attempt made to locate the potential source of the problem. A change in a C-200-series tank waste volume, plus the volume of water used for the tank retrieval, exceeding the volume retrieved into AN-106 by a quantity greater than the limit of error associated with the system may indicate a potential leak. Should this happen, any water additions to the tank would be halted, any visible pools removed and the equipment temporarily shut down while the problem was evaluated further. Following evaluation, the retrieval process would likely be restarted. Whether further restrictions would be imposed on the retrieval process cannot be stated before such an evaluation. All obvious leak minimization steps will have already been undertaken during the retrieval process, as described in Section 4.6.1. Control of a benchmark level in C-203 for receipt of drain water solutions generated during C-203 retrieval is specified in *Process Control Plan for the 241-C-200 Series*

Waste Retrieval System, RPP-16945. Benchmark levels for tanks during waste retrieval are specified in Section 4.6.1.

4.5.2 Performance of Leak Detection and Monitoring for Tank C-202 During Storage of Tanks C-201 and C-204 Drain Water

The Enraf will be in service on tank C-202 during the time drain water is being received from tanks C-201 and C-204 waste retrieval. Readings will be taken and documented on the frequency stated in Section 4.6.2, or once per waste transfer period when operating whichever is more frequent. This frequency may vary depending upon operations and engineering need. When the level in tank C-202 is below about 1,100 gallons the Enraf will be inoperable since the plummet will rest on the curved portion of the tank bottom, and there will be no level monitoring available. Visual imaging to observe gross level changes would be possible only if a video camera is installed, one is not currently planned for use during storage only conditions.

If the level is above 1,100 gallons, the Enraf plummet will be able to sense a level change. The accuracy of the Enraf is ±0.04 inches, and is calibrated to ±0.1 inches. For a C-200-series tank ±0.1 inches is equivalent to ±15 gallons at the level where the plummet will begin to float, and range up to about ±20 gallons at the level where the sidewall levels out. The usefulness of the level data will be dependent upon the rate at which material comes into the tank and how long the level remains quiescent before the next addition. With no liquid additions to the tank, the level drop specification limit of -0.5 inch established in Table 2.2 of OSD-T-151-00031 for waste storage will be used as a criterion for implementation of a leak assessment. Thus, a leak assessment would be instigated should there be an unexplained level decrease of 75 to 100 gallons in tank C-202, if the starting volume in tank C-202 is sufficiently above 1,100 gallons to indicate this size of a leak.

The material balance data obtained during waste transfer mass balance periods is evaluated when calculated, so any anomalies, assuming the level in tank C-202 is above 1,100 gallons should be noted within a day or so of the reading during quiescent conditions. Control of a benchmark level in C-202 when used as a drain water receiver for C-202, C-201 and C-204 retrieval is specified in RPP-16945. Assessment of a tank C-202 level drop during drain water additions will be more difficult, and the results will be subjective. No specific value can be given for the size of leak that could be spotted in this instance because of the large number of variables. Frequent air separator additions could mask any small leaks.

4.5.3 Performance of Leak Detection and Monitoring for Aboveground Skids

The aboveground skids are designed to be compliant with WAC-303-640(3). The batch vessel is evaluated in *Integrity Assessment Report Slurry Vessel for C-200 Tank Retrieval* (FFS-ENG-02-0604) provided in Appendix A. The batch vessel is shown to meet WAC-303-640(3) (see Sections 4.7.2.5 and 4.7.2.8).

The leak detectors for the skid drains will alarm and shut off transfers with less than a few gallons leaked to the drain. The timing for leak detection will be dependent upon the leak rate and how fast it runs across the floor to the drain. The maximum volume of the batch vessel is about 300 gallons and the maximum volume of the air separator is about 50 gallons. The holdup in each secondary containment is approximately 1,000 gallons so each skid can hold the maximum leakage from the vessel in the skid.

Operating procedures provide for over-fill controls, there is also a high level alarm for both the batch vessel and the air separator. Should either vessel over-fill, the solution does not go to the secondary containment. The liquid would remain in the system piping and eventually go back to the tank being retrieved. Some of the liquid could flow to the drain water receiver tank, either tank C-203 or C-202. Data sheets and checklists are maintained per procedures *Startup/Shutdown of 241-C-200 Tanks WRS Support/Utility Systems* (TO-320-030) and *Transfer from 241-C-200 Series Tanks to 241-AN-106* (TO-220-106) to show work progress.

4.5.4 Performance of Leak Detection and Monitoring for Receiver Tank AN-106

The leak detection monitoring for tank AN-106 is the current operating system governed by OSD-T-151-00031. No changes are made for C-200-series tank waste retrievals. Therefore there is no change from the existing approved system performance.

4.5.5 Performance of Leak Detection and Monitoring for Transfer Lines

Leak detectors are verified operable as specified in TO-220-106 and *Perform Functional Test for C-200 Series Tanks Transfer Line Leak Detectors and Shutdown Panel* (TF-FT-369-001). Transfer line leak detectors alarm when sufficient liquid is accumulated to set off the detector. The volume required to set off a detector depends upon the geometry of the location for the detector. A leak of only a gallon or less will set off a detector if the leak occurred nearby, but if a leak occurred in an encased line and had to travel a long distance before reaching a leak detector location the leakage volume would be larger at the time the leak detector was activated. The maximum size of the leak would thus depend upon the size and length of the encasement. At the worst case, assuming a transfer line failure near the top of the hose-in-hose transfer line (HIHTL) in AN tank farm, and assuming the encasement filled completely with liquid before draining to a leak detection point in C tank farm, the maximum leak volume before the pumps were shut off could be several hundred gallons. Any leakage would drain to a receiver tank. The C-200-series waste retrieval transfer pumps will shut down automatically upon a leak detector alarm.

4.6 MITIGATION STRATEGY

The primary procedures governing notification and reporting of leaks are *Occurrence Reporting and Processing of Operations Information* (TFC-OPS-OPER-C-24) and *Environmental Notification* (TFC-ESHQ-ENV_FS-C-01). The following paragraphs provide excerpts from the versions of these procedures in effect at the time this document was released. They are to be used as guidance only. For complete wording of all the steps and requirements not listed below, refer to the actual procedures. Should there be any differences between the statements below and the procedures, the procedures take precedence.

Any occurrence within tank farms is evaluated per TFC-OPS-OPER-C-24 for reporting requirements. For spills, releases, or tank leaks associated with an SST, aboveground skid, transfer line, or receiving tank the steps in TFC-OPS-OPER-C-24, Revision A-6 require:

1. Determine if an event or condition meets the emergency action levels in "Emergency Plan Implementing Procedures" (DOE-0223). Requirements for responding to these "classified emergencies," including prompt notification, are found in DOE-0223.

2. If the event or condition is not a classified emergency, the base program operational emergency criteria in TFC-OPS-OPER-C-24 are reviewed, and requirements completed, as described. The base program operational emergency criteria related to environmental conditions excerpted from TFC-OPS-OPER-C-24, Revision A-6 include:

   - Any actual or potential release of hazardous material or regulated pollutant to the environment in a quantity greater than five times the reportable quantity specified for such material in 40 CFR 302 that could result in significant off-site consequences such as major wildlife kills, wetland degradation, aquifer contamination, or the need to secure downstream water supply intakes.

   - Any release of greater than 1,000 gallons (24 barrels) of oil to inland waters; greater than 10,000 gallons (238 barrels) of oil to coastal waters; or a quantity of oil that could result in significant off-site consequences (e.g., need to relocate people, major wildlife kills, wetland degradation, aquifer contamination, need to secure downstream water supply intakes, etc.). (Oil means any kind of oil, including petroleum, per 33 U.S.C. 1321). NOTE: This is not an identified Hanford hazard.

   If the event or condition meets one of the base program operational emergency categories, TFC-OPS-OPER-C-24, Revision A-6 provides a number of steps to follow leading up to the point where the environmental notification procedure TFC-ESHQ-ENV_FS-C-01 is applied. The significant steps excerpted from TFC-OPS-OPER-C-24, Revision A-6 include:

   - As soon as possible (within 30 minutes), notify the Occurrence Notification Center (ONC) at 376-2900 of any preliminary information (this information may not include details). Taking mitigative actions to stabilize the facility/operation to a safe condition shall take precedence over notifications

   - Notify facility management and the on-call DOE Office of River Protection (ORP) facility representative.

   - Using the assistance of the ONC and RPP facility management, categorize base program operational emergencies.

     - NOTE 1: All events categorized as base program operational emergencies are automatically reported to off-site agencies as abnormal events.

     - NOTE 2: Base program operational emergencies also require a prompt notification fax or electronic mail to the ONC within 90 minutes of categorization, and a written occurrence report

   - Contact Tank Farm Contractor Environmental Program in accordance with the on-call list. Refer to TFC-ESHQ-ENV_FS-C-01 for reporting requirements

3. If the event or condition does not meet base program operational criteria, the abnormal event categories in TFC-OPS-OPER-C-24 are reviewed, and requirements completed, as described. The abnormal event criteria related to environmental conditions or a potential DST leak identified in TFC-OPS-OPER-C-24, Revision A-6 include:

   - Facility Condition – any event or condition disrupting facility operations (excluding false indicators) or causing degradation of safety class systems.

   - Environmental - any unplanned release of a radiological or hazardous substance above established limit defined in applicable regulations and requiring verbal notification to a regulator.

   - Environmental - any spill or release to the environment from a tank farm waste tank or associated transfer line.

   - Environmental - any event or condition affecting ecological resources (i.e., destruction of a critical habitat, damage to a historic/archeological site, damage to wetlands, etc.) or agreement/compliance areas reportable to a regulator

   - Cross-Category Items - Any event which results in or may result in media attention or public concern.

   If the event or condition meets one of the abnormal event categories, TFC-OPS-OPER-C-24, Revision A-6 provides a number of steps to follow leading up to the point where the environmental notification procedure TFC-ESHQ-ENV_FS-C-01 is applied. The significant steps excerpted from TFC-OPS-OPER-C-24, Revision A-6 include:

   - As soon as possible (within 30 minutes), notify the ONC at 376-2900 of any preliminary information (this information may not include details). Taking mitigative actions to stabilize the facility/operation to a safe condition shall take precedence over notifications.

   - If the ONC declares an abnormal event, notify facility management and the on-call DOE Office of River Protection (ORP) facility representative.

   - Contact Tank Farm Contractor Environmental Program in accordance with the on-call list. Refer to TFC-ESHQ-ENV_FS-C-01 for reporting requirements

4. If the event or condition is not a base program operational emergency or an abnormal event, the occurrence report criteria in TFC-OPS-OPER-C-24 are reviewed, and requirements completed, as described. The occurrence categories and associated criteria relevant to waste retrieval include the following excerpts from TFC-OPS-OPER-C-24, Revision A-6:

   - Group 4 – Facility Status; Subgroup A – Safety Structure/System/Component Degradation

     – Performance degradation of any Safety Class or Safety Significant Structure, System, or Component (SSC) that prevents satisfactory performance of its design function when it is required to be operable.

- Group 5 -- Environmental, Subgroup A – Releases (Note: Contact Tank Farm Contractor Environmental (Per the on-call list in accordance with TFC-ESHQ-ENV_FS-C-01))

  - Any release (on-site or off-site) of a hazardous substance, material, waste, or radionuclide from a DOE facility, that is above permitted levels and exceeds the reportable quantities specified in 40 CFR 302 or 40 CFR 355.

  - Any discharge that exceeds 100 gallons of oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil. For operations involving oil field crude or condensate, any discharge of 100 barrels or more is reportable under this criterion.

  - Any release (on-site or off-site) of a hazardous substance, material, waste, or radionuclide from a DOE facility that is above permitted levels and exceeds 50 percent of the reportable quantities specified in 40 CFR 302 or 40 CFR 355.

  - Any release (on-site or off-site) of a hazardous substance, material, waste, or radionuclide from a DOE facility that must be reported to outside agencies in a format other than routine periodic reports. (However, oil spills of less than 10 gallons and with negligible environmental impact need not be reported in ORPS.)

- Group 10 – Management Concerns/Issues

  - Any event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the facility manager or line management to be of safety significance or of generic interest/concern to other facilities or activities in the DOE complex.

  - Any occurrence that may result in a significant concern by an affected state, tribal, local officials, press, or general population, or that could damage the credibility of the Department, or that may result in inquiries to DOE Headquarters.

If the event or condition meets one of the occurrence reporting criteria TFC-OPS-OPER-C-24, Revision A-6 provides a number of steps to follow leading up to the point where the environmental notification procedure TFC-ESHQ-ENV_FS-C-01 is applied. The significant steps associated with occurrence reporting excerpted from TFC-OPS-OPER-C-24, Revision A-6 include:

- Initiate or complete the immediate actions necessary to stabilize the facility/operation to a safe condition and preserve conditions for subsequent investigation.

- Gather all pertinent information relating to the event/condition with as minimal operational interference as possible.

- Notify the building emergency director and shift manager, as appropriate.

- If the event is a spill, release, fire, explosion, or permit exceedence, contact Tank Farm Contractor Environmental Program in accordance with the on-call list. Describe the circumstances of the event, the substance, and the quantity released. Refer to TFC-ESHQ-ENV_FS-C-01 for further information.

- Report in accordance with TFC-ESHQ-ENV_FS-C-01.

Procedure TFC-ESHQ-ENV_FS-C-01 implements regulatory agency reporting requirements and applies to all tank farm contractor activities. This procedure provides instructions for the reporting of spills, releases, fires, explosions, etc., to regulatory agencies. Section 4.2 of TFC-ESHQ-ENV_FS-C-01, Revision B-1 provides the response for spills and releases and Section 4.5 provides the response for DST RCRA leak detection.

There are 19 steps to follow for spills and releases. The applicable steps related to Ecology notification excerpted from TFC-ESHQ-ENV_FS-C-01 include:

- Notify Tank Farm Contractor Environmental personnel of the leak

- Determine if the spill or release exceeds the 40 CFR 302 reportable quantity for the material.

- Determine if a Resource Conservation and Recovery Act of 1976 contingency plan needs to be implemented.

- Notify Ecology and Washington State Department of Health if the reportable quantity has been exceeded and/or the Resource Conservation and Recovery Act of 1976 contingency plan has been implemented. Note: these notifications are performed per specific requirements on a two page checklist and faxed to the listed parties no later than noon of the next business day.

There are six steps to follow for DST RCRA Leak Detection. The response to a potential DST leak would be the same regardless of whether the leak was due to a transfer leak into the annulus or a leak of the DST primary tank. Notifications are performed per specific requirements on a two page checklist and faxed to the listed parties no later than noon of the next business day. The following specific conditions associated with DST leak detection that require Ecology notification are excerpted from TFC-ESHQ-ENV_FS-C-01, Revision B-1:

- Leak detection equipment preventive maintenance or functional testing that will exceed 24 hours down time

- Leak detection equipment repair that will require more than 90 days to complete

- Annulus leak detector alarms that are not due to operational activities; intrusion caused alarms which do not clear within four hours of annunciation must be reported

- Operating annulus continuous air monitor readings that equal or exceed the continuous air monitor alarm set point, and are not due to atmospheric radon or its decay products, or not due to operational activities (e.g., annulus contamination due to vacuum imbalance between annulus and primary tank ventilation system or other operational activity).

4.6.1 Leak Mitigation for Waste Retrieval Tank Leak

Leak minimization for a waste retrieval tank leak will be provided by actions taken during waste retrieval. These include the following:

- Addition of water to the retrieval tank is minimized and liquid pools that form are removed as practical.
- Waste is retrieved to the extent practical by working from the center of the tank outwards.
- Retrieval activities are performed only while a video camera is in place to observe the AMS suction nozzle and waste surface.
- Equipment handling controls are used to minimize the potential for dropping equipment into the tank, which could penetrate the tank bottom during installation.
- The hydraulic pressure to the AMS is reduced to the extent practical while still permitting acceptable AMS operation to minimize the potential for putting excessive pressure on the tank wall during waste retrieval operations.
- Maintaining a benchmark level in each tank. The waste level shall not exceed this benchmark. For tank C-203, the benchmark is 17 inches. For tank C-202 during waste retrieval, the benchmark is 12 inches or the initial reading of the Enraf gauge, whichever is greater. For tank C-201, the benchmark is 14 inches. For tank C-204, the benchmark is 24 inches.

All these actions minimize the potential leak volume before a leak occurs, not after a leak is discovered. Should the WUF calculated from the tank material balance be greater than zero, Ecology will be notified per TFC-ESHQ-ENV_FS-C-01 and a leak assessment performed per *Tank Leak Assessment Process* (TFC-ENG-CHEM-D-42).

If there is a need to operate the system longer than the estimated time periods stated in Section 4.8.1 to demonstrate the limit of the technology to recover waste that is difficult to retrieve, the basic leak minimization step is still to limit the volume of any free liquid in the tank.

4.6.2 Leak Mitigation for Tank C-202 Leak During Receipt of Drain Water from Tanks C-201 and C-204 Retrieval

Leak minimization is provided in part by retrieving the waste in tank C-202 to the maximum extent practical before using it for receipt of tank C-201 or C-204 drain water. This prior retrieval minimizes the waste material present should a leak occur during the subsequent storage. A benchmark level for tank C-202 during waste retrieval from tanks C-201 and C-204 is 25 inches. Should the level rise above 12 inches, the Enraf level gauge shall be read daily.

Below 1,100 gallons in tank C-202 there will be no leak mitigation as there will be no level monitoring available. Should a leak be noted when there is above 1,100 gallons in tank C-202, Ecology would be notified per TFC-ESHQ-ENV_FS-C-01 and in accordance with WAC 173-303-640(7). Mitigation would be provided by temporarily halting waste retrieval operations in tank C-201 or C-204 and all additional liquid additions to tank C-202 stopped. The retrieval line between the batch vessel and tank C-202 would be reattached and the liquid in tank C-202 removed. A different tank (likely C-201) would then be selected to receive drain water during the remaining retrieval of waste from tanks C-201 and C-204.

4.6.3 Leak Mitigation for Aboveground Skid Leakage

A leak within the skids will drain to the drain water receiver tank, C-203 or C-202, not to the environment. Should a leak occur within the skid, the waste retrieval process would be halted automatically when the leak detectors activate and shut down the transfer pumps. The process could also be halted manually if the leak is spotted earlier by a video camera. The leak would then be fixed or the leak location bypassed before the process was restarted. The response to a leak is the same regardless of leak rate. An occurrence report may be issued depending upon whether the leak met the reporting requirements of TFC-OPS-OPER-C-24.

Any leakage within the skids is contained by the secondary containment. In the unlikely event that equipment failure causes leakage to the environment from the secondary containment the Environmental Compliance group would be notified and the steps in procedure TFC-ESHQ-ENV_FS-C-01 implemented for reporting requirements and in adherence with WAC 173-303-640(7).

4.6.4 Leak Mitigation for Receiving Tank Leak

Following is a discussion of leak mitigation actions for a DST. A more detailed discussion can be found in *Double-Shell Tank Emergency Pumping Guide* (HNF-3484) and *Time Deployment Study for Annulus Pumping* (RPP-5482).

Actions taken in the event of a leak of waste from primary tank piping into the secondary containment system of the DST system, or other receiver tank, during a waste transfer from an SST to a DST include stopping the flow of waste into the tank system (stopping the transfer) pumping waste in the primary tank to another DST until the liquid level in the secondary containment is no longer increasing, and removing the waste from the secondary containment system as soon as practicable. Tanks that develop leaks at or near the tank bottom may also require salt well jet pumping to remove trapped liquids from between solid layers in the tank.

The only receiver tank for the C-200-series tank wastes is a DST. There are no double-contained receiver tanks or catch tanks along the transfer route between the batch vessel/pump skid and tank AN-106. Transfer line leakage will drain back to the batch vessel/pump skid and from there to the drain water receiver tank (see Section 4.6.3).

The above leak detection and mitigation systems are approved and implemented through the DST RCRA permitting process.

4.6.5 Leak Mitigation for Transfer Line Leak

Response to transfer leak detection alarms is performed per procedure TO-220-106.
Leak detection is performed in a similar manner to, and response is similar to that for, existing tank farm transfers. There is nothing unique to the C-200-series tank waste retrieval leak

detection system logic when compared to existing tank farms transfer leak detection. Leak mitigation is provided by the design of equipment that channels all leakage into an outer encasement that drains to an alarmed location and a collection tank. The transfer is shut down when the alarm occurs.

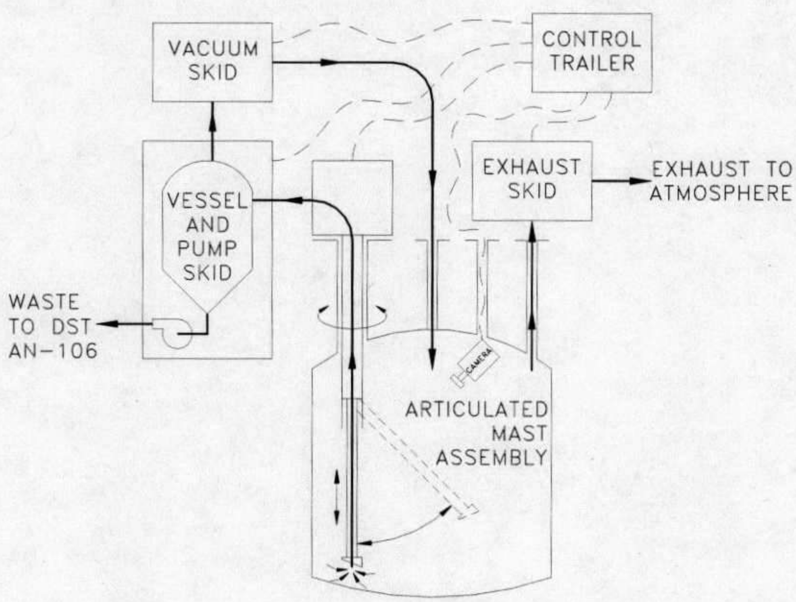
4.7 SYSTEM DESCRIPTION

The waste retrieval and LDM systems described in this section represent an overview of the system currently planned for deployment in the C-200-series tanks. Modifications during fabrication and resulting from testing and deployment may change the system configuration as it is described herein. However, the final design shall comply with the requirements established in this document.

4.7.1 Waste Retrieval System Description

The C-200-Series Tanks Project will use a vacuum retrieval system that utilizes an articulating mast to remove waste from the tank. Both air and water are injected at the vacuum head to mobilize the waste. If needed, a series of five scarifying, high-pressure, low-volume water jets located around the outside of the vacuum head can be used to dislodge waste. The waste is deposited in a batch vessel located above grade in the vessel/pump skid where load cells and a level gauge indicate the waste batch volume. The batch vessel is a slurry tank with an approximate 300-gallon capacity and a working volume of less than 250 gallons. The recovered waste will be mixed and diluted as necessary for transfer through a hose-in-hose assembly to tank AN-106 (Figure 8).

Figure 8. Waste Retrieval System Diagram



Both the vessel/pump skid and the vacuum skid provide secondary containment and leak detection. Both skids provide for leak collection and drainage back to one of the C-200-series tanks. The drain lines will be routed to tank C-203 during retrieval of waste from that tank.

During retrieval of waste from tanks C-201, C-202, and C-204 the drain lines will be routed to tank C-202.

The vacuum will be produced by tandem vacuum pumps installed upstream of the waste receiving vessel. The tandem vacuum pumps provide a level of redundancy in that normally only one pump would be operated. The system does have the capability to run both of the vacuum pumps simultaneously if needed for waste removal.

Miscellaneous process and skid drainage will be routed back to either tank C-203 (during retrieval of waste from tank C-203) or tank C-202 (see Figure 7). During routine operations contaminated seal water from the vacuum system and line drainage will be generated and routed back to either tank C-203 (during retrieval of tank C-203) or tank C-202. Also, under upset or emergency conditions, waste contained in the batch vessel can be drained back to tank C-203 or C-202 as part of recovery actions.

The system design is intended for multiple deployments and will typically be comprised of skids and modular assemblies. The major components of the system include the following:

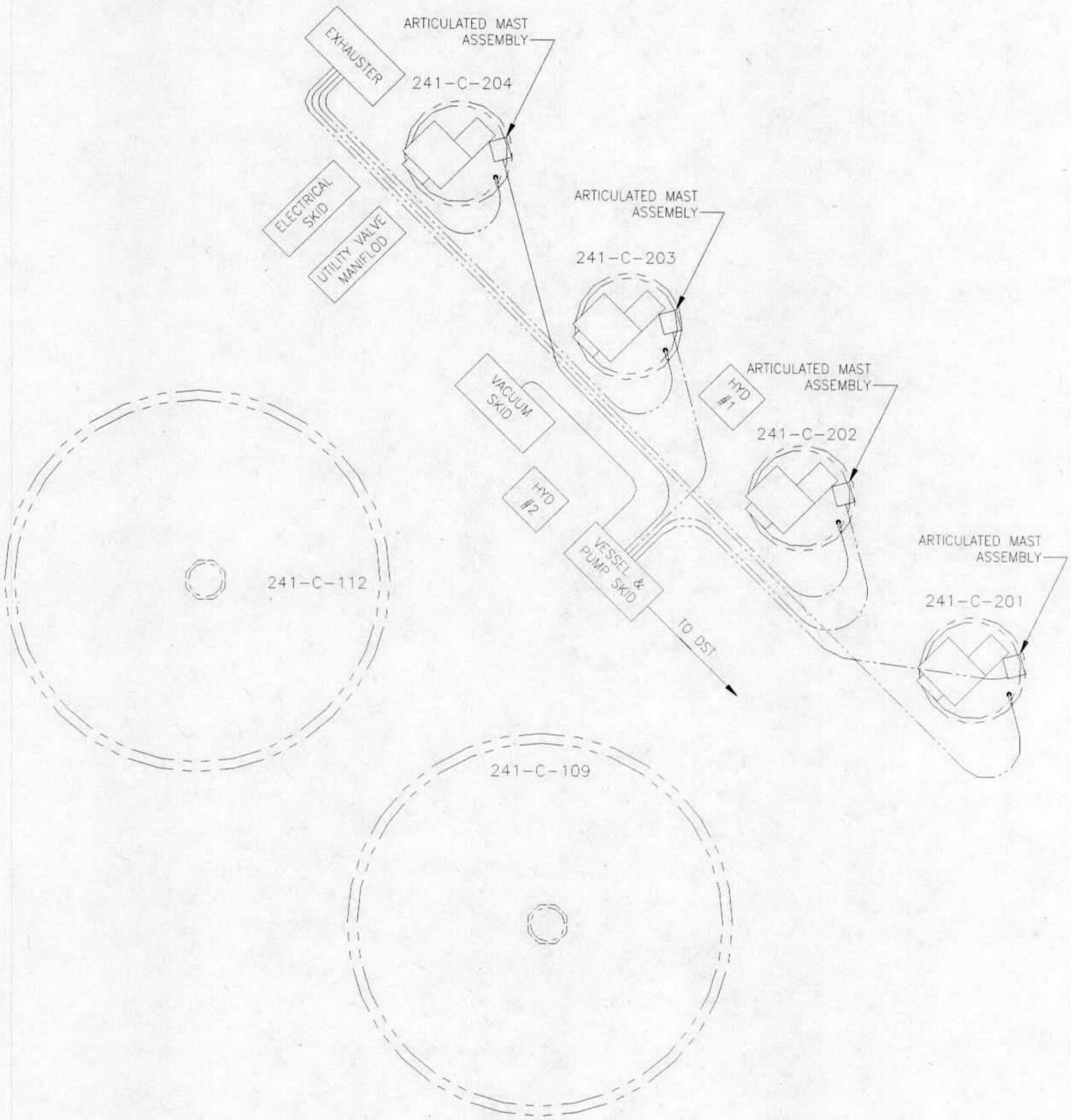
- Articulated mast assemblies (one each for tanks C-201, C-202, C-203, and C-204)
- Vessel and pump skid
- Vacuum skid
- Hydraulic power packs
- Exhauster skid
- Compressed air skid
- Water supply skid
- Closed-circuit television camera
- Control trailer.

The modular design of the system incorporates many redundant items to improve operating reliability. The skids also incorporate maintenance features that allow repair, and/or replacement of many components in the event of a component failure. Redundant slurry pumps are provided in the vessel/pump skid that provide the capability to transfer waste out of the slurry vessel in the event that one of the pumps fail. Should a redundant equipment item fail, changeover to use of the spare would likely take only a few hours, or less. Spare parts required to support operations have been evaluated and procured to support system operations.

The ventilation for the secondary containment for the aboveground skids is via breather filters. The secondary containment in the aboveground skids is ambient air, all primary containment equipment is vented back to the retrieval tank. The retrieval tank is exhausted and operated under radiological *NOC Approval for 241-C-200-Series Tanks Retrieval* (NOC AIR-04-401) from Washington Department of Health. The toxics new source review for the exhauster stream was submitted to Ecology by the Office of River Protection with "New Source Review Exemption Notification for Installation and Operation of a Waste Retrieval System in Single-Shell Tanks (SST) 241-C-201, C-202, C-203, and C-204" (Rasmussen 2003). Ecology did not respond within the regulatory 30-day period and the NSR was therefore approved.

A possible arrangement for the equipment is shown in Figure 9.

Figure 9. C-200-Series Waste Retrieval Site Plan



4.7.2 Aboveground Skid Information

This section is added to this document at the request of Ecology to provide specific information related to use and disposition of the aboveground equipment skids which will be used for temporary containment of retrieved liquid wastes. There are two skids used for temporary containment of liquid wastes. These are the Vessel and Pump Skid and the Vacuum Skid.

4.7.2.1 General Arrangement Diagram

Figure 9 portrays where the skids are planned to be located. Figure 9 provides the equipment layout as of August 2003, but should not be assumed to be the layout for the entire waste retrieval process. The layout may be changed per equipment configuration control procedures to improve operation or meet different requirements; however, this F&R document will not be revised each time a layout change is made.

4.7.2.2 System Description

The vacuum skid provides the suction for the retrieval process while the vessel and pump skid receives the waste from the tank being retrieved and transfers it to the receiver tank in AN farm. A system description is provided in Section 4.7.1.

4.7.2.3 Piping and Instrumentation Diagrams (P&IDs)

There are approximately 20 P&IDs associated with the C-200 vacuum retrieval process. Of these, one P&ID is specific to the vessel and pump skid and one to the vacuum skid. These are drawings H-14-106126, sheet 7, and H-14-106126, sheet 8. Since these drawings are periodically updated as necessary to portray the current status of the equipment it is impractical to include P&IDs as part of this document. Copies of the latest revision of the P&IDs are available within the Hanford electronic document control system.

4.7.2.4 Process Flow Diagram

Figure 10 provides a process flow diagram for the C-200-series retrieval system. Figure 10 provides a rough estimate of the flow rate ranges for all tanks combined, and for the tank with the most waste, C-203. The values are rough estimates only based upon cold testing and early operating experience, final values may be outside the ranges given once operating conditions are established and the suitable operating parameters are determined for those conditions.

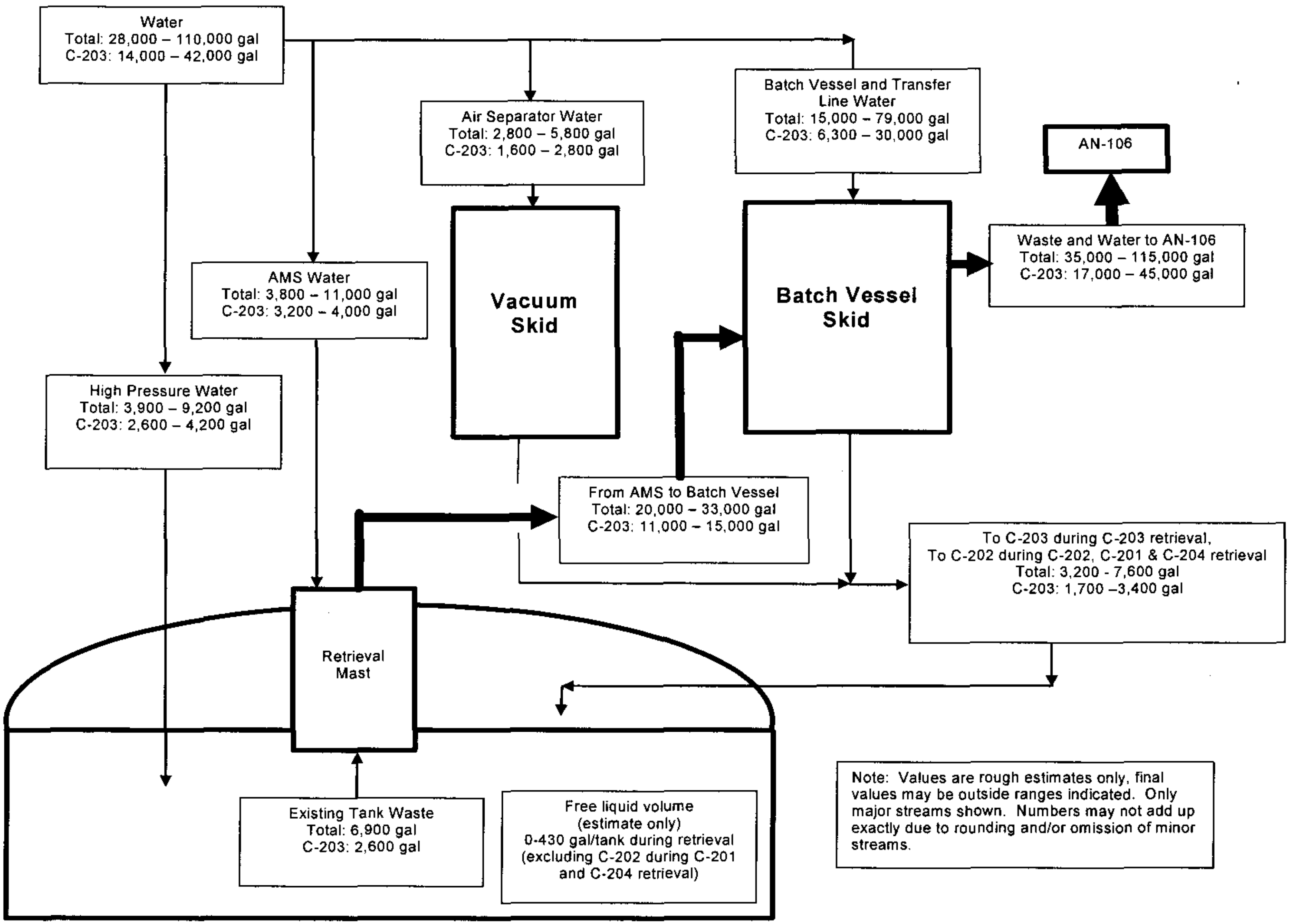
4.7.2.5 Information to Demonstrate Compliance with WAC 173-303-640

Documentation concerning the compliance with WAC 173-303-640 and a compliance matrix that crosswalks the requirements of WAC 173-303-640 to the design features and/or operating plans is provided in Appendix B.

4.7.2.6 Disposition of System at Completion of Waste Retrieval

When waste retrieval operations have been completed for all four C-200-series tanks, the pump skid and vacuum skid will either be transferred to a different location within tank farms for use in another vacuum waste retrieval, or disposed of as waste.

Figure 10. C-200 Retrieval Simplified Process Flow Diagram



Note: Values are rough estimates only, final values may be outside ranges indicated. Only major streams shown. Numbers may not add up exactly due to rounding and/or omission of minor streams.

If the equipment is used at a different location, it will be decontaminated before transport to the extent necessary to reach acceptable exposure rates for dismantling and moving the equipment for reuse at other tanks. Decontamination will involve flushing vessel and piping internals with water. Almost all of the flush water will go to tank AN-106. However, the nominal 30 gallons of drain water in the air separator vessel of the vacuum skid will be drained back to the last tank to which the skid drainage is attached (planned to be tank C-202). Additional liquid may drain back from piping internals or the exhauster seal pot. It is planned to use an air blow to empty the HIHTL between the vessel/pump skid and tank AN-106 following completion of C-200-series tank waste retrieval activities. If this air blow is unsuccessful, the nominal 150 gallons of flush water in the line would drain back to C-202 (or the last tank to which the skid drainage is attached). This drainage is unavoidable and cannot be subsequently removed from the tank via the AMS because the liquid is required in the air separator to provide a seal liquid for the vacuum pumps.

If the equipment is to be stored before use at another location, storage of the skids is done per *Contaminated Equipment Management Practices* (TFC-OPS-WM-C-10). Setup of the equipment at a different waste retrieval location will be covered under the Tank Waste Retrieval Work Plan (TWRWP) for that operation, additional setup is beyond the scope of this F&R document.

If the useful life of the equipment is through and it is to be disposed of as radioactive mixed waste it will be disposed of per procedures and requirements in effect at that time. The skids and their contents will be disposed of to meet the approved waste acceptance criteria for the onsite burial grounds as well as the land disposal restrictions of WAC 173-303-140.

The HIHTLs associated with the vacuum and batch vessel skids are managed in accordance with *Temporary Waste Transfer Line Management Program Plan* (RPP-12711).

4.7.2.7 Description of Skid Flushing, Movement and Post-Move Integrity Assessment

When the vacuum and vessel/pump skids are no longer needed for the C-200-series tank waste retrieval they will be flushed to reduce dose rates and liquids drained from the equipment as described in Section 4.7.2.6. If the vacuum and vessel/pump skids are to be moved to another location for subsequent retrieval the packaging and transport of the equipment will be performed in accordance with procedure "Radioactive Material/Waste Shipments" (HNF-IP-0842, Volume 18, Section 2.1).

If the equipment is to be reused for another waste retrieval it will be set up and operationally tested for conformance to design and operational requirements for that retrieval, and any required integrity assessment performed per documentation controlling that subsequent retrieval. Reuse of the equipment shall be consistent with WAC 173-303-640 (2). Equipment setup, verification of operability, and/or integrity assessment for waste retrievals other than C-200-series tanks is beyond the scope of this F&R document.

4.7.2.8 Integrity Assessment Report

Appendix A provides a copy of the integrity assessment report for the vessel/pump skid for C-200-series waste retrieval.

4.7.2.9 Compliance With WAC 173-303-806

USDOE is addressing the requirements of WAC 173-303-806 (4)(a)(viii) (E) and (F) during waste retrieval by handling the waste in accordance with all applicable regulations under the authority of the Atomic Energy Act, including the Department of Energy orders. An example order is DOE O 440.1a, "Worker Protection Management for DOE Federal and Contractor Employees". This order requires the development of a Health and Safety Plan (HASP). The HASP describes how workers are protected while in and around tank farms. Though the HASP and other such documents, DOE orders, and actions under the Atomic Energy Act do not fall under the authority of Ecology, those orders and actions meet the requirements of WAC 173-303-806 relative to protection of the worker from exposure to dangerous waste.

4.8 OPERATING STRATEGY

The operating strategy for performing LDM and retrieval applies before, during, and after waste retrieval is described in the following sections. The strategy is consistent with the current level and maturity of the C-200-series tank WRS design, as well as consistent with the F&R established in this document.

4.8.1 Waste Retrieval Operations

The overall waste retrieval operating strategy will consist of vacuum retrieval of the tank waste inventory while minimizing liquid pooling during waste retrieval operations. The process will be monitored using closed-circuit television to facilitate waste retrieval and minimize free liquid in the tank. The composite material removed will consist of both mobilized tank waste and water used to affect mobilization.

Until operating experience is obtained with the vacuum retrieval system, the time required to retrieve waste from the C-200-series tanks can only be roughly estimated. The retrieval time for one tank could be as short as 2 days or as long as 130 days. The most conservative estimate for completing all four tanks is approximately one year.

Resource limitations, equipment difficulties, and the implementation of a new technology never before used for radioactive waste retrieval make it impractical at this time to provide solid estimates for the times involved. Different batch waste loadings or operating efficiencies, operating problems, and/or different batch cycle times will proportionately affect the waste retrieval times.

The vacuum waste retrieval process is performed while minimizing the liquid present in the retrieval tank. However, water is used in the vacuum waste retrieval process for a variety of purposes that include the following streams:

1. High-pressure water to scarifier on AMS head used to mobilize or break up hard waste
2. Water to flush AMS union if needed
3. Water to backflush line from batch vessel to AMS
4. Water to AMS suction line to aid in transfer of waste to batch vessel
5. Makeup water to air separator
6. Water to mobilize waste in batch vessel for transfer to DST
7. Water to backflush line between air separator and batch vessel

8. Water to prime and flush transfer pump
9. Dilution water for waste transfer to keep waste density in transfer line within limits
10. Water to flush transfer line to DST.

In addition, liquid may drain to the drain water receiver tank (C-203 or C-202) from the following stream sources:

11. Condensate drain from vacuum skid air conditioner
12. Condensate drain from vessel/pump skid air conditioner
13. Floor drainage from leak in vacuum skid
14. Floor drainage from leak in vessel/pump skid
15. Water held up in batch vessel piping that may 'bounce' into vacuum relief line to tank when vacuum is released
16. Seal pot drainage from exhauster seal pot
17. Water to flush batch vessel to drain water receiver tank if needed to reduce dose rate for skid entry
18. Water to calibrate instrumentation.

Two more streams may be added to the retrieval or drain water receiver tank following completion of waste retrieval. These solutions should be transferred to AN-106:

19. Final tank wall and bottom flush
20. Equipment decontamination flush if needed to reduce dose rate so equipment can be handled for the next configuration.

One stream may be added to the retrieval or drain water receiver tank following completion of waste retrieval.

21. Drainback from last air separator tank drain, miscellaneous piping drainage, exhauster seal pot drainage, and final flush water from HIHTL to tank AN-106 (if air blow of line is unsuccessful).

Of these, streams 1, 2, 3, and a small fraction of 4 are sent to the retrieval tank during waste retrieval. In stream 1, the high-pressure water is estimated to be greater than 90% of the sum of all four, the remainder will either be zero or small.

Streams 5, 11, 12, 13, 14, 15, 16, and a small fraction of stream 17 drain to the drain water receiver tank (tank C-203 during waste retrieval of tank C-203; tank C-202 during the waste retrieval of tanks C-202, C-201, and C-204). Stream 5, the air separator water, is estimated to be greater than 95% of the sum of all eight, the remaining seven streams will either be zero or small.

Streams 6, 7, 8, 9, 10 and the large majority of streams 4 and 17 are sent from the batch vessel skid direct to tank AN-106; they do not enter the retrieval or drain water receiver tank.

Stream 18 will consist of a yearly generation of a nominal 1000 gallons of drain water. This would be pumped to tank AN-106. Under certain conditions a fraction of this could be drained to the drain water receiver tank depending upon conditions and calibration status of equipment at the time calibrations are performed.

A decision on performing a final tank bottom flush, stream 19, will be made at the end of waste retrieval for each tank. If the residual waste adhering to the tank walls and bottom is sufficiently small that there is less than 30 ft^3 of waste remaining in the tank, the flush may not be needed. However, if there is more than 30 ft^3 of waste remaining in the tank it may be necessary to flush material located on the tank bottom in locations inaccessible to the AMS, to reduce the tank residual waste volume. Any final flush water is removed after it is added to the tank.

Stream 20 liquid will be dependent upon dose rate conditions following retrieval. If personnel exposures can be kept low while handling the equipment there may be no flush required. High dose rates will require flushing until personnel can effectively handle the equipment. The volume of water necessary for such flushing cannot be known in advance, but three equipment volumes of water passed through both skids would be less than 1,000 gal.

Liquid waste volumes associated with stream 21 are discussed in Section 4.7.2.6.

Figure 10 provides an estimated range for the water usage for the tank with the most volume, C-203, and for all four tanks combined. Predicted volumes are based upon flowsheet estimates made following cold testing using assumed minimum and maximum water usage for various streams and tank C-203 waste retrieval usage through July 23, 2004. The minimum value shown is believed to represent the best that can be done. Actual volumes will be above the range given if waste characteristics encountered are markedly different than assumed or if equipment problems occur.

Streams 6, 9, and 10 represent the vast majority of water used in the C-200-series drain retrieval process. The volume of water associated with streams going to the retrieval or waste water receiver tank(s) is expected to be only a small fraction of the total water used for the vacuum retrieval process. The vast majority of the water used in the vacuum retrieval process goes to the batch vessel skid and from there direct to tank AN-106, not to the retrieval or drain water receiver tank(s).

Liquid added to the retrieval tank during retrieval, or to the drain water receiver tank when that tank is also being retrieved, is removed as soon as practical. With the exception of tank C-202 during the retrieval of waste from tanks C-201 and C-204, regardless of the retrieval duration the liquid is removed to the extent practical by the vacuum system as it is introduced and does not continue to build up in the tank. Should there be a simultaneous failure of both vacuum pumps or some other equipment failure occur which prevents retrieval of liquid added to a tank (excluding tank C-202 during retrieval of tanks C-201 and C-204) the likely volume of pooled liquid that would remain in the tank until the equipment failure was fixed is estimated at less than a nominal 430 gallons.

The volume of free liquid present during retrieval operations is minimized and should be less than 50 gal most of the time. This free liquid could increase with time with the center-out waste removal sequence if the retrieval process is halted for an extended length of time and interstitial liquid not retained by capillary action slowly drains to the central depression. The maximum pool size resulting from such drainage is estimated to be less than 100 gallons. Should it prove necessary to use more high pressure spray water than planned to mobilize the waste for retrieval there could be more than 100 gal present if a lot of the water runs off to form several adjacent pools, but pooling will still be minimized to the extent practical. If a full suction line flush occurred concurrently with a dual vacuum pump failure, or some other failure that renders the vacuum system inoperable, there could be an estimated additional 80 gallons of water added to the tank that would remain until the failure was repaired. Should the batch vessel need to be drained to C-202 or C-203 during the retrieval of either of these tanks an additional 250 gallons could be added.

Thus, the volume of free liquid present in a tank being retrieved should be less than 100 gallons most of the time, but under certain conditions with concurrent failures or activities occurring up to 430 gallons could be present. The length of time this free liquid would remain in the tank will be dependent upon the time to repair the equipment, which could be hours to weeks.

4.8.2 Liquid Additions and Timing

This section is added to this document to address specific questions from Ecology in regards to expected or planned liquid additions and timing, with details requested on anticipated volume additions, timing, total water used, an estimate for the number of days for retrieval and a clarification of the assumptions and bases used.

Figure 10 provides an estimate of sum of the various liquid additions for all tanks, and for the individual tank with the highest estimated waste volume, tank C-203. The sum of the additions for the remaining three tanks is equal to the total volumes given in Figure 10 minus the tank C-203 volumes. The individual additions associated with the remaining three tanks are estimated to be in roughly the same proportions as the individual tank waste volumes.

Section 4.8.1 discusses over 20 different water usage locations in the C-200-series retrieval process. Many of these should be zero or quite small. The timing for water additions is not scheduled. The timing cannot be estimated more than a day or two in advance due to many competing factors, all that can be provided in advance is a rough description of the process which includes what the major water additions are and when they are made.

When retrieval operations are begun, water is added up the AMS as needed to enhance retrieval. At the same time, high pressure spray water is added to the waste around the suction nozzle to breakup and/or fluidize the waste near the nozzle as needed. When the batch vessel has accumulated enough waste and water to make a transfer, vacuuming is halted along with any AMS or high-pressure water. Water is then added to the batch vessel as needed to fluidize the waste for transfer, and the waste pumped to the receiver tank. During transfer, water is added to the transfer line as necessary to maintain the average solution density below an engineering determined value. When the transfer is completed the transfer line is flushed as required per procedure. The air separator for the vacuum blower discharge is also drained and water added for refill as needed during the process. This is done before or after a batch transfer when needed, or automatically when a high level alarm is activated in the air separator.

Section 4.8.1 states a likely minimum and maximum waste retrieval time for a C-200-series tank. A wide range is stated for a tank waste retrieval time since there are many factors unrelated to retrieval operations that can, and will, influence the retrieval times. Should all the equipment operate as designed and there be no factors unrelated to retrieval which impede operation, retrieval should be able to be completed for a C-200-series tank within a few weeks, or less. Depending upon the operability of the equipment and factors unrelated to retrieval, the retrieval operations could stretch out to a year to complete all four tanks, as stated in Section 4.8.1.

4.8.3 Final Volume Measurement

At the conclusion of waste retrieval, the residual waste volume will be estimated. It is planned to use a video camera for this measurement. The in-tank video will be made using standard in-tank video procedures. A 360° view, or as much as practical, of the tank walls will be made as well as the tank bottom. Residual waste volume on the walls will be visually estimated or calculated. Residual waste volume on the tank bottom will be estimated based upon interpretation of the video.

The current sampling strategy includes pre-retrieval sampling of the waste in the tanks. A decision on post retrieval sampling will be made after retrieval. Any post retrieval sampling or residual waste volume measurements shall be made in compliance with RPP-16616 and the approved sampling and analysis plan.

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APPENDIX A
COPY OF INTEGRITY ASSESSMENT REPORT SLURRY VESSEL FOR C-200-SERIES TANK WASTE RETRIEVAL

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FFS-ENG-02-0604

INTEGRITY ASSESSMENT REPORT

SLURRY VESSEL for
C-200 SERIES TANK RETRIEVAL

June 2004

Prepared for
CH2M HILL Hanford Group, Inc.
by
Fluor Federal Services
Richland, Washington

FFS-ENG-02-0604

STRUCTURAL INTEGRITY ASSESSMENT CERTIFICATION

I certify, under penalty of law, that this document and all attachments were prepared or collected under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

ALBERT W. BJORKEDAL
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20627
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PROFESSIONAL ENGINEER

Albert Bjorkedal 6/30/04

EXPIRES 9/18/04

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FFS-ENG-02-0604

TABLE OF CONTENTS

FFS-ENG-02-0604

INTEGRITY ASSESSMENT REPORT

SLURRY VESSEL
FOR
C-200 SERIES TANK RETRIEVAL

1.0 INTRODUCTION

The Hanford Site is located in the arid southeast region of Washington State. Since the 1940s, an extensive network of underground piping and waste tanks has been installed to contain caustic radioactive wastes. Systems are being installed to support retrieval of materials from single-shell tanks and transfer to double-shell tanks.

1.1 Purpose

The assessment report satisfies the "design and installation of new tank systems or components" certification requirements for Washington Administrative Code (WAC) 173-303-640(3), *Design and Installation of New Tank Systems or Components*, for the Slurry Vessel supporting retrieval of wastes from the 241-C-200 Series Tanks.

The purpose of this report is to document an independent review of the vessel design to meet the requirements of WAC 173-303-640, *Tank Systems* (Reference 1). During preparation of this report, guidelines provided by Ecology Publication 94-114 were followed (Reference 2).

1.2 Scope

Systems are being installed to support retrieval programs of the 241-C-200 Series Tanks in the 241-C Tank Farm complex, an existing facility. This integrity assessment addresses the design and installation of the Slurry Vessel installed to support removal of waste from the 241-C-200 Series Tanks.

1.3 System Description and Operation

1.3.1 Existing Tank Farm Complex

The 241-C Tank Farm complex, constructed from 1943 to 1945, is located in the 200-East Area of the Hanford Site. The tank farm is comprised of single-shell, waste storage tanks and associated piping and support systems. The 200 series tanks, 20 foot diameter with working volume of 55,000 gallons, received waste from the Hot Semiworks. The waste is stored in a buffered (high pH) state (reference 3). The tanks and associated piping are buried below ground for tank farm accessibility and radiation shielding purposes.

1.3.2 Slurry Vessel

The Slurry Vessel is installed above grade in a skid mounted ISO container, referred to as the Vessel/Pump Skid. The skid is installed in the 241-C tank farm near the C-200 Series Tanks (Figures 1 and 2). The vessel will provide intermediate storage for waste drawn by vacuum from the C-200 tanks.

The vessel is approximately 43 inches diameter by 69 inches overall height, of carbon steel construction, designed and fabricated to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section VIII, Division 1 (see figure 3). Connections to the vessel include instrumentation, slurry inlet, vacuum suction, vacuum manifold, drain, slurry outlet, an access manway, and "HydroTrans." The HydroTrans installed in the bottom of the vessel will fluidize the materials retrieved from the C-200 tanks, for discharge to existing double shell storage tanks (see figure 4).

The vessel has a maximum capacity of approximately 290 gallons, with a working volume of approximately 250 gallons. The floor below the vessel provides leak containment, sloped to a leak detection directly beneath the vessel. The floor is seal welded to the side walls of the container. At each end of the container are bolted and caulked steel plates, that constitute a drip pan (~1' H X 8' W X 20' L), for the vessel and pipeworks inside of the ISO container. The drip pan volume containment capacity is ~1000 gallons. The slurry vessel and pipework maximum volume is ~320 gallons or ~30% of the containment capacity of the drip pan. With leak detection shutdown of the system, there is adequate conservatism for maximum spill and containment capability.

The vessel is mounted by carbon steel legs to a carbon steel equipment housing. The vessel is coated with a durable industrial coating (epoxy type, SigmaCover CM Coating). Double doors at each end of the container are required to be closed during any process operation. These doors also provide adequate protection of the environment outside of the ISO container as they are compressed gasketed and hard latched.

Operating procedures are in place to ensure the safety of personnel and the environment. These procedures include monitoring equipment, including leak detection, recording results of radiation surveys, and following detailed operating procedures.

1.4 Certification

Page i contains the certification statement attesting to the accuracy of the information presented in this report. The certification statement is signed and sealed by an Independent Qualified Registered Professional Engineer (IQRPE) in accordance with WAC 173-303-810(13)(a), *Certification*.

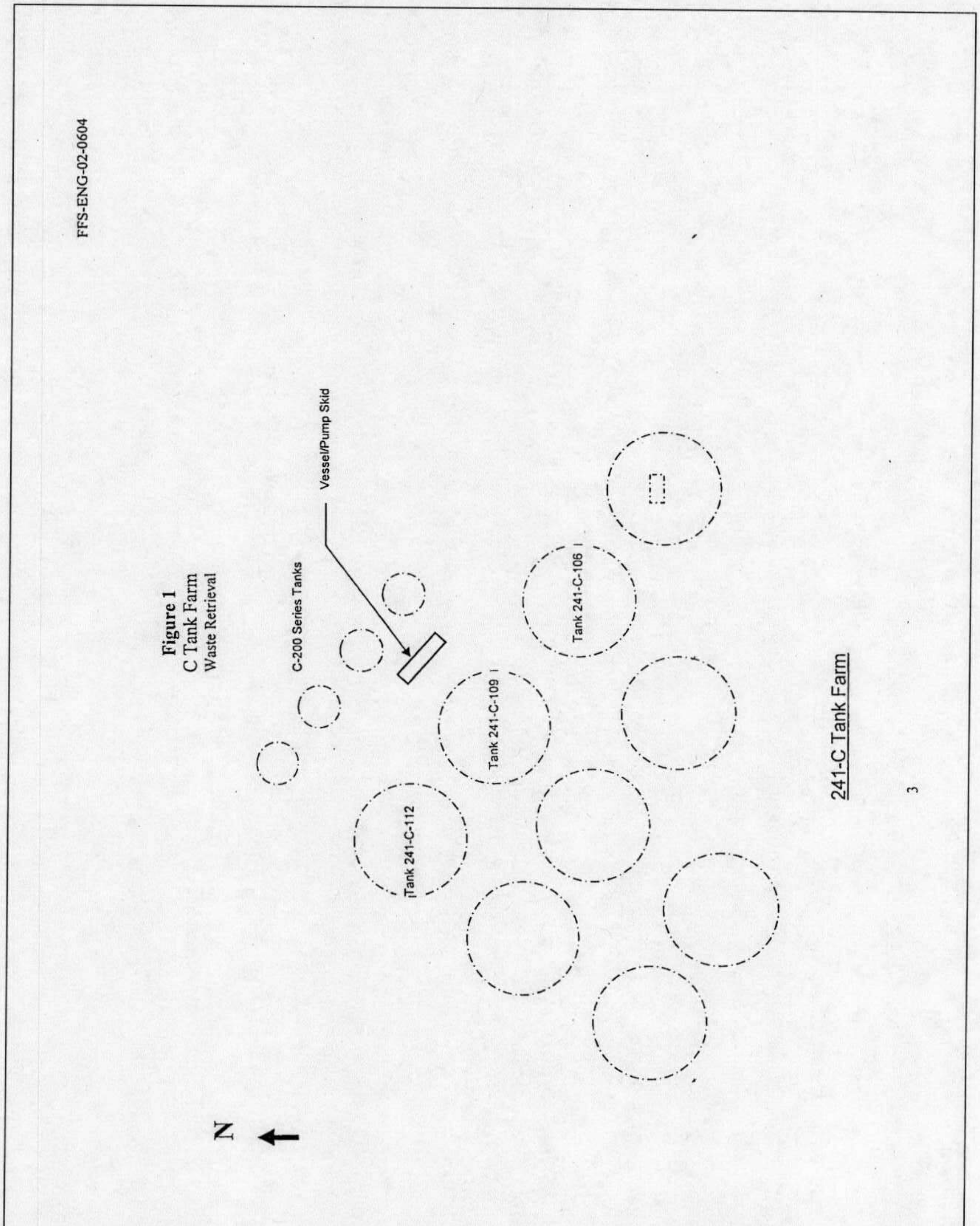
FFS-ENG-02-0604
Figure 1
C Tank Farm
Waste Retrieval
C-200 Series Tanks
Vessel/Pump Skid
Tank 241-C-106
Tank 241-C-109
Tank 241-C-112
241-C Tank Farm
N

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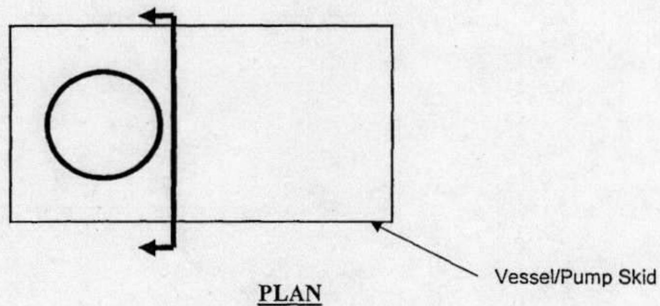
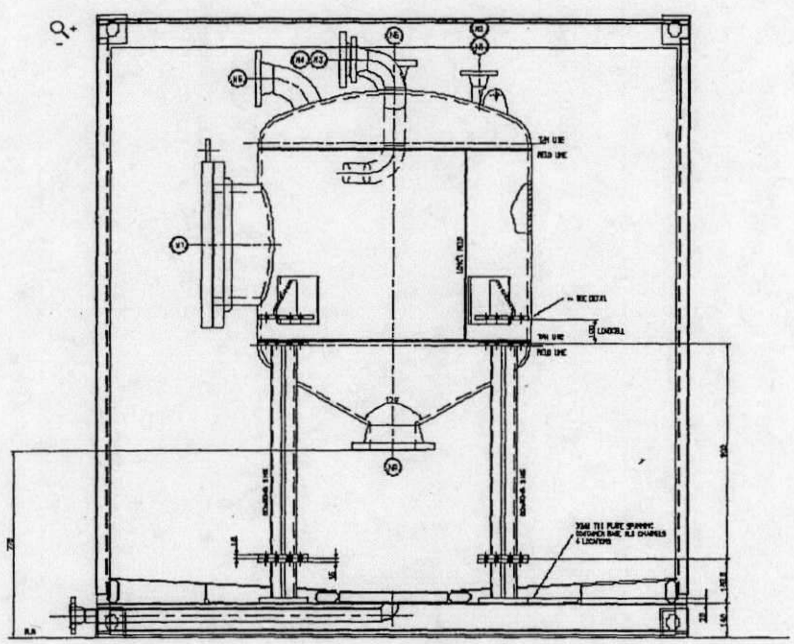
FIGURE 2
Slurry Vessel, mounted on Vessel/Pump Skid



PLAN



ELEVATION

4

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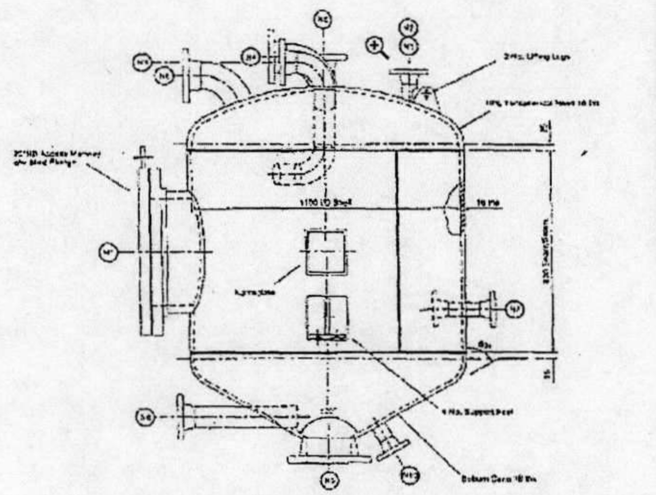
Figure 3
Slurry Vessel



Nozzle Schedule						
Ref	Qty	Size	Flange Rating/Type	Neck Sch	Description	Notes
M1	1	20" NB	150# ANSI RF SO	100	Access Manway	c/w Blind Flange
N1	1	2" NB	150# ANSI RF WN	160	Low Level Instrument	
N2	1	2" NB	150# ANSI RF WN	160	High Level Instrument	
N3	1	3" NB	150# ANSI RF WN	160	Slurry Inlet	c/w Ext'l & Int'l Elbows
N4	1	4" NB	150# ANSI RF WN	120	Vacuum Suction	c/w External Elbow
N5	1	3" NB	150# ANSI RF WN	160	Spare	
N6	1	4" NB	150# ANSI RF WN	120	Vacuum Manifold	c/w External Elbow
N7	1	2" NB	150# ANSI RF WN	160	Hydrotrans Outlet	c/w Int'l Pipe & Flange
N8	1	3" NB	150# ANSI RF WN	160	Hydrotrans Inlet	Set Thru' Bottom Cone
N9	1	8" NB	150# ANSI RF WN	100	Slurry Outlet	
N10	1	2" NB	150# ANSI RF WN	160	Drain Outlet	

5

FFS-ENG-02-0604

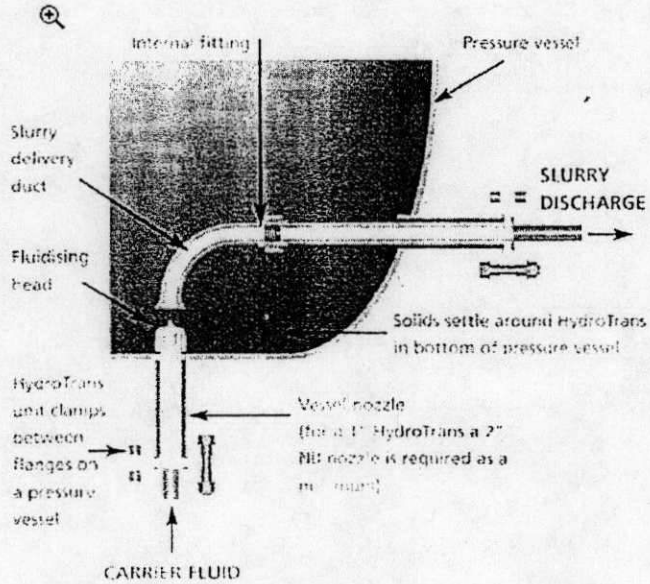


Figure 4, HydroTrans Schematic

6

2.0 ASSESSMENTS

2.1 Design Assessment

The design assessment is based on applicable codes, standards, design, vendor information, construction documents, and photos. Design documents include the engineering change notices (ECNs), drawings, and calculations.

2.1.1 Design Codes and Standards

The vessel installation was designed and fabricated to:
ASME B&PV, *Boiler and Pressure Vessel Code,* Section VIII, Division 1, 2001 Edition.
ASME B31.3 (Chemical Piping)
British Standard EN1011 (Welding of Carbon Steel)
Uniform Building Code, 1997 Edition
ICBO, ER-3631 (Anchors)
ACI 301, "Specifications for Structural Concrete for Slabs on Grade and Structural Slab"
ACI 318, "Building Code Requirements for Reinforced Concrete"
AISC Manual of Steel Construction, 9th Edition
TFC-ENG-STD-06, Rev A, *Hanford Design Standard: Design Loads for Tank Farm Facilities*
DOE-STD-1020-02, *Natural Phenomena Hazard Design and Evaluation Criteria for Department of Energy Facilities*

The ASME, British, UBC, ICBO, ACI and AISC are consensus codes and standards that are appropriate for the vessel and installation. The Hanford and DOE standards provide additional appropriate requirements for the Hanford DOE Site.

2.1.2 Waste Characteristics

The vessel, as installed in the waste retrieval system, will contain materials that are basic (pH between 9 and 11) and will be relatively low temperature (less than 100 F). The physical properties of these materials are documented in reference 3.

2.1.3 Corrosion Protection Determination

The vessel is fabricated of carbon steel. The materials being transferred into the vessel for intermediate holding have been stored in the carbon steel lined C-200 series tanks for many years. The materials are basic (pH in the 9 to 11 range). Water is being introduced into the retrieved material to fluidize it for transfer to the double shell tanks. Therefore, internal corrosion will not be an issue. The exterior of the vessel has been coated with a durable industrial protective coating (epoxy type, SigmaCover CM Coating), and the vessel is installed within a closed container.

2.2 Construction Assessment

The vessel installation had been completed prior to determination by the CH2M HILL to require an independent integrity assessment. The construction assessment is based upon inspections performed by qualified inspectors and fabrication photos, and documentation of the inspections is compiled in the installation and fabrication packages. Additionally, the IQRPE visited the installation site during the installation of the Vessel/Pump skid while performing independent assessment for installation of the hose-in-hose transfer lines that are attached to the Vessel/Pump skid. Therefore, the IQRPE has complete confidence in this certification.

Following is a discussion of the installation inspections specifically required by WAC 173-303-640(3).

2.2.1 General Inspections

Inspections were performed to determine if any structural damage occurred during the installation phase and to assess the quality of workmanship. Inspection personnel were on site to verify that correct materials and procedures were used for the following activities:

- Visual inspection and pressure testing

2.2.1.1 Weld Breaks

The vessel was fabricated to the requirements of ASME Section VIII, Division 1. The vendor's program, which is certified by the ASME authorized inspector (Lloyds), assures that the vessel meets the quality requirements of ASME, which include welding by qualified welders, weld inspection (including some radiograph), use of certified materials, and successful passing of pressure testing. Therefore, there are no weld breaks in the vessel.

2.2.1.2 Punctures

Pressure testing of the vessel by the fabricator verified that no punctures exist. Receiving inspection verified that no damage had occurred during shipment.

2.2.1.3 Damage to Protective Coatings

There is no protective coating on the interior of the vessel. The vessel is installed within a weatherproof enclosure and the system is not dealing with any materials that are aggressive to carbon steel. Therefore the interior of the vessel will not require any protective coating. However, given the nature of materials being retrieved, the exterior protective coating has been applied to the vessel and it will enhance clean up of equipment. Based on photos and receiving inspection, there is no damage to that protective coating.

2.2.1.4 Cracks

Based on inspections performed, cracks were not apparent in support structures.

2.2.1.5 Other Information

Structural damage or inadequate construction/installation is not evident.

2.2.2 Backfill Material

No backfill material was required for this vessel since it is skid-mounted above grade.

2.2.3 Tightness Testing

The vessel was successfully pressure tested in accordance with the requirements of ASME B&PV Code Section VIII, Division 1.

2.2.4 Equipment Support

The vessel is installed with adequate support to prevent physical damage and excessive stresses due to settlement, vibration, expansion and contraction, and seismic activity.

2.2.5 Corrosion Protection

The exterior of the vessel is not exposed to the soil or water. Therefore, corrosion protection beyond the industrial coating has not been applied.

2.2.6 Documentation of Inspection Results

Documentation of the inspections is compiled in the field installation and fabrication packages and in the vendor's submittal package.

3.0 CONCLUSION

The Slurry Vessel has been adequately designed and installed for the service to be encountered. The vessel, along with the skid and foundation on which it is mounted, have sufficient strength for the design conditions. The vessel is compatible with the waste and material it will contain. These characteristics ensure that the vessel will not collapse or fail at design conditions. Furthermore, proper fabrication, installation, and test procedures were followed.

FFS-ENG-02-0604

4.0 REFERENCES

1. Washington Administrative Codes (WAC)
173-303, *Dangerous Waste Regulations*
173-303-640, *Tank Systems*
173-303-640(3), *Design and Installation of New Tank Systems or Components*
173-303-640-810(13)(a), *Certification*

2. Publication 94-114, *Guidance for Assessing and Certifying Tank Systems that Store and Treat Dangerous Waste*, June 1994, Washington State Department of Ecology

3. RPP-19131, Rev. 1, *UltrasonicDeagglomeration in the 200 SeriesRetrieval,* December 2003, D.A. Reynolds

4. 4112-VC001 Rev A, *Design Calculations for 1100 l/D Slurry Tank*, February 2003, Total Technology Design Partnership Ltd

10

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APPENDIX B
COMPLIANCE OF C-200-SERIES TANK RETREIVAL EQUIPMENT WITH WAC 173-303-640

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APPENDIX B
COMPLIANCE OF C-200-SERIES TANK RETREIVAL EQUIPMENT WITH WAC 173-303-640

The e-mail and attached letter on the following page were sent from the Office of River Protection to the Washington State Department of Ecology on February 20, 2004 in response to an Ecology request. The letter indicates the aboveground retrieval equipment used for C-200-series retrieval is in compliance with the WAC with the exception of the IQPRE assessment. Ecology subsequently responded with letter *Re: C-200 Functions and Requirements Document (RPP-16525, Rev. 2), "Washington State Department of Ecology Request for Evaluation of the Status of the 241-C-200 Series Tanks", from Roy Schepens to Mike Wilson, dated December 30, 2003,* March 5, 2004, Jeff Lyon, Ecology, to R. J. Schepens, ORP, permitting start of C-200-series equipment retrieval.

Table B.1, following the e-mail and attached letter, provides a crosswalk of the WAC 173-303-640 requirements to the design feature and/or operating plans for the aboveground vacuum and vessel/pump skids, and related ancillary equipment.

From: Noyes, Delmar L
Sent: Friday, February 20, 2004 3:19 PM
To: Hedges, Jane; Cusack, Laura J; Lyon, Jeffery
Cc: Luke, Jeffrey J; Thompson, James F Jr; Quintero, Roger A; Jarayssi, Moses; Swailes, John H
Subject: C-200 RCRA complaince message.

Jane,

Thanks for the support on this issue. If there are any question please let me know.

Delmar.

COMPLIANCE STATUS OF THE 241-C-200 SERIES TANK ABOVE GROUND RETRIEVAL SYSTEM

The State of Washington, Department of Ecology (Ecology) has verbally requested assurance that the above ground portion of the 241-C-200 Series tank retrieval system meets the Resource Conservation and Recovery Act (RCRA) requirements and standards, with the exception of certification by an independent, qualified registered professional engineer (IQRPE), as referenced in Washington Administrative Code Chapter 173-303, Dangerous Waste Regulations, Subpart 640, Tank Systems. Ecology has requested that this assurance be provided prior to Ecology's approval of the C-200 Series retrieval.

The above ground transfer system consists of hose-in-hose transfer lines (HIHTL), an American Society of Mechanical Engineers (ASME) stamped tank (ASME VIII, Division 1), full containment of the tank, vacuum pumps and associated support equipment, leak detection in the containments and HIHTL, and drain lines which drain the containments to one of the C-200 tanks. Although a written assessment, reviewed and certified by an IQRPE, has only been obtained for the HIHTL, the entire above ground transfer system is designed to, and will be operated to, the standards contained in WAC 173-303-640 (3), (4), (5), (6), (7), (9), and (10).

The C-200s retrieval is expected to start 3/29/04 with the C-203 tank as currently configured. The duration of the retrieval is anticipated to be 2 to 4 weeks. The start of retrieval of the remaining C-200s tanks will be delayed to reroute the drain paths as requested by Ecology. All four of the C-200 series tanks will be retrieved within the 12 months currently under discussion with Ecology. The retrieval durations the other C-200 series tanks will be similar to C-203. This schedule is based on the anticipated expectations communicated in Ecology's approval of the C-200 Series retrieval.

If you have any questions concerning this matter you may contact me or your staff may contact Mr. P. C. Miller at 373-1920.

Sincerely,

Delmar L. Noyes
Director, Tank Farms Programs and Project Division.
Office of River Protection

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(1)	applicability	Applicable, no explanation required
(1)(a)	applicability	Applicable, no explanation required
(1)(b)	applicability exemption	NA - not exempted
(1)(c)	applicability exemption	NA - not exempted
(1)(d)	applicability, use with drip pans	NA to these skids
(2)	existing tank system integrity	NA - this is new equipment
(2)(a)	existing tank system integrity	NA - this is new equipment
(2)(b)	existing tank system integrity	NA - this is new equipment
(2)(c)	existing tank system integrity	NA - this is new equipment
(2)(c)(i)	existing tank system integrity	NA - this is new equipment
(2)(c)(ii)	existing tank system integrity	NA - this is new equipment
(2)(c)(iii)	existing tank system integrity	NA - this is new equipment
(2)(c)(iv)	existing tank system integrity	NA - this is new equipment
(2)(c)(v)	existing tank system integrity	NA - this is new equipment
(2)(c)(v)(A)	existing tank system integrity	NA - this is new equipment
(2)(c)(v)(B)	existing tank system integrity	NA - this is new equipment
(2)(d)	existing tank system integrity	NA - this is new equipment
(2)(e)	existing tank system integrity	NA - this is new equipment
(3)	Design and Installation of New Tank Systems	Applicable, no explanation required
(3)(a)	IQRPE assessment	See Appendix A
(3)(a)(i)	IQRPE assessment - design standards	See Appendix A

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(3)(a)(ii)	IQRPE assessment – dangerous waste characteristics	See Appendix A
(3)(a)(iii)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(I)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(II)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(III)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(IV)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(V)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(VI)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(VII)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(A)(VIII)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(B)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(B)(I)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(B)(II)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iii)(B)(III)	IQRPE assessment - soil contact	NA – externals of tanks not in contact with soil
(3)(a)(iv)	underground system - vehicle traffic	NA – not underground tank system
(3)(a)(v)	underground system - design	NA – not underground tank system
(3)(a)(v)(A)	underground system - foundations	NA – not underground tank system
(3)(a)(v)(B)	underground system - flotation	NA – not underground tank system

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(3)(a)(v)(C)	underground system - frost heave	NA – not underground tank system
(3)(b)	schedule for integrity assessments	The skids will be installed in a different location for each retrieval setup and be present for a limited period of time. An integrity assessment was performed following setup for the C-200 retrieval. An integrity assessment will be provided as required for each retrieval setup, in accordance with WAC 173-303-640 (2).
(3)(c)	procedures to prevent installation damage	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(i)	procedures to prevent installation damage - weld breaks	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(ii)	procedures to prevent installation damage - punctures	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(iii)	procedures to prevent installation damage - scrapes	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(iv)	procedures to prevent installation damage - cracks	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(v)	procedures to prevent installation damage - corrosion	Installation done per approved work packages, see Appendix A for inspection results.
(3)(c)(vi)	procedures to prevent installation damage - other damage	Installation done per approved work packages, see Appendix A for inspection results.
(3)(d)	backfill for underground tanks	NA – not an underground system
(3)(e)	testing for tightness	See Appendix A
(3)(f)	support of ancillary equipment	See Appendix A
(3)(g)	corrosion protection requirements	See Appendix A
(3)(h)	certification of design & installation	See Appendix A
(4)	containment & leak detection	Applicable, no explanation required
(4)(a)	containment & leak detection - applicability	Applicable, no explanation required

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(4)(a)(i)	containment & leak detection -new systems	Applicable, no explanation required
(4)(a)(ii)	containment & leak detection - applicability	NA – not an existing tank
(4)(a)(iii)	containment & leak detection – applicability	NA – not an existing tank
(4)(a)(iv)	containment & leak detection – applicability	NA – not an existing tank
(4)(a)(v)	containment & leak detection – applicability	NA – skids are covered by (4)(a)(i)
(4)(b)	secondary containment criteria	Applicable, no explanation required
(4)(b)(i)	secondary containment criteria -prevent leakage	See 4.2.1.3, 4.5.3, 4.6.3
(4)(b)(ii)	secondary containment criteria -detect/collect leakage	See 4.2.1.3, 4.5.3, 4.6.3
(4)(c)	secondary containment criteria -general	Applicable, no explanation required
(4)(c)(i)	secondary containment criteria -construction	See Appendix A
(4)(c)(ii)	secondary containment criteria -foundation	See Appendix A
(4)(c)(iii)	secondary containment criteria -detect liquid in secondary containment	See 4.2.1.3, 4.5.3, 4.6.3, Appendix A
(4)(c)(iv)	secondary containment criteria -sloped drainage	See 4.2.1.3, 4.5.3, 4.6.3, leakage to floor of skids goes to drains via sloped floor, liquid entering drain goes to receiver tank via sloped lines
(4)(d)	secondary containment criteria	Applicable, no explanation required
(4)(d)(i)	secondary containment criteria -liner	NA – secondary containment provided by skid enclosure (vault)
(4)(d)(ii)	secondary containment criteria -vault	Applicable, no explanation required
(4)(d)(iii)	secondary containment criteria -double wall tank	NA – secondary containment provided by skid enclosure (vault)

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(4)(d)(iv)	secondary containment criteria -equivalent	NA – secondary containment provided by skid enclosure (vault)
(4)(e)	secondary containment criteria additional criteria	Applicable, no explanation required
(4)(e)(i)	secondary containment criteria -external liners	NA – not an external liner.
(4)(e)(i)(A)	secondary containment criteria -external liners	NA – not an external liner.
(4)(e)(i)(B)	secondary containment criteria -external liners	NA – not an external liner.
(4)(e)(i)(C)	secondary containment criteria -external liners	NA – not an external liner.
(4)(e)(i)(D)	secondary containment criteria -external liners	NA – not an external liner.
(4)(e)(ii)	secondary containment criteria -vaults	Applicable, no explanation required
(4)(e)(ii)(A)	secondary containment criteria -vaults-capacity	See 4.5.3
(4)(e)(ii)(B)	secondary containment criteria -vaults-precipitation	The skids are enclosed, any rainfall runs off the outside. Should there be a penetration of the secondary containment permitting rainwater to enter, the rain would alarm the leak detector.
(4)(e)(ii)(C)	secondary containment criteria -vaults-chemical resistant water stops at joints	Joints in containment area are all welded and painted carbon steel.
(4)(e)(ii)(D)	secondary containment criteria -vaults-interior coating or lining	Containment is painted carbon steel resistant to water and alkaline waste.
(4)(e)(ii)(E)	secondary containment criteria -vaults-vapor ignition	Secondary containment vents via breather filter. Primary containment vents back to tank being retrieved which is exhausted. Tank internal components are required to meet, and meet, safety basis requirements for flammable atmospheres.
(4)(e)(ii)(E)(I)	secondary containment criteria -vaults-vapor ignition definition	NA – not ignitable waste

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(4)(e)(ii)(E)(II)	secondary containment criteria -vaults-vapor ignition definition	Secondary containment vents via breather filter. Primary containment vents back to tank being retrieved which is exhausted. Tank internal components are required to meet, and meet, safety basis requirements for flammable atmospheres.
(4)(e)(ii)(F)	secondary containment criteria -moisture barrier is subject to hydraulic pressure	NA – vault not subject to hydraulic pressure
(4)(e)(iii)	secondary containment criteria -double wall tanks	NA – not a double walled tank
(4)(e)(iii)(A)	secondary containment criteria -double wall tanks	NA – not a double walled tank
(4)(e)(iii)(B)	secondary containment criteria -double wall tanks	NA – not a double walled tank
(4)(e)(iii)(C)	secondary containment criteria -double wall tanks	NA – not a double walled tank
(4)(f)	ancillary equipment - secondary containment must meet (b) and (c) except for …	Applicable, no explanation required
(4)(f)(i)	ancillary equipment - secondary containment -exception	NA – secondary containment provided by skids and HIHTLs
(4)(f)(ii)	ancillary equipment - secondary containment -exception	NA – secondary containment provided by skids and HIHTLs
(4)(f)(iii)	ancillary equipment - secondary containment -exception	NA – secondary containment provided by skids and HIHTLs
(4)(f)(iv)	ancillary equipment - secondary containment -exception	NA – secondary containment provided by skids and HIHTLs
(4)(g)	variances	NA – no variance being requested
(4)(g)(i)	variances	NA – no variance being requested
(4)(g)(i)(A)	variances	NA – no variance being requested
(4)(g)(i)(B)	variances	NA – no variance being requested
(4)(g)(i)(C)	variances	NA – no variance being requested

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(4)(g)(i)(D)	variances	NA – no variance being requested
(4)(g)(ii)	variances	NA – no variance being requested
(4)(g)(ii)(A)	variances	NA – no variance being requested
(4)(g)(ii)(A)(I)	variances	NA – no variance being requested
(4)(g)(ii)(A)(II)	variances	NA – no variance being requested
(4)(g)(ii)(A)(III)	variances	NA – no variance being requested
(4)(g)(ii)(A)(IV)	variances	NA – no variance being requested
(4)(g)(ii)(A)(V)	variances	NA – no variance being requested
(4)(g)(ii)(B)	variances	NA – no variance being requested
(4)(g)(ii)(B)(I)	variances	NA – no variance being requested
(4)(g)(ii)(B)(II)	variances	NA – no variance being requested
(4)(g)(ii)(B)(III)	variances	NA – no variance being requested
(4)(g)(ii)(B)(IV)	variances	NA – no variance being requested
(4)(g)(ii)(C)	variances	NA – no variance being requested
(4)(g)(ii)(C)(I)	variances	NA – no variance being requested
(4)(g)(ii)(C)(II)	variances	NA – no variance being requested
(4)(g)(ii)(C)(III)	variances	NA – no variance being requested
(4)(g)(ii)(C)(IV)	variances	NA – no variance being requested
(4)(g)(ii)(C)(V)	variances	NA – no variance being requested
(4)(g)(ii)(D)	variances	NA – no variance being requested
(4)(g)(ii)(D)(I)	variances	NA – no variance being requested
(4)(g)(ii)(D)(II)	variances	NA – no variance being requested
(4)(g)(iii)	variances	NA – no variance being requested
(4)(g)(iii)(A)	variances	NA – no variance being requested
(4)(g)(iii)(B)	variances	NA – no variance being requested
(4)(g)(iii)(B)(I)	variances	NA – no variance being requested
(4)(g)(iii)(B)(II)	variances	NA – no variance being requested
(4)(g)(iii)(C)	variances	NA – no variance being requested
(4)(g)(iv)	variances	NA – no variance being requested
(4)(g)(iv)(A)	variances	NA – no variance being requested
(4)(g)(iv)(B)	variances	NA – no variance being requested
(4)(g)(iv)(C)	variances	NA – no variance being requested

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(4)(h)	variances	NA – no variance being requested
(4)(h)(i)	variances	NA – no variance being requested
(4)(h)(i)(A)	variances	NA – no variance being requested
(4)(h)(i)(B)	variances	NA – no variance being requested
(4)(h)(ii)	variances	NA – no variance being requested
(4)(h)(iii)	variances	NA – no variance being requested
(4)(h)(iv)	variances	NA – no variance being requested
(4)(i)	variances	NA – no variance being requested
(4)(i)(A)	variances	NA – no variance being requested
(4)(i)(B)	variances	NA – no variance being requested
(4)(i)(C)	variances	NA – no variance being requested
(4)(i)(D)	variances	NA – no variance being requested
(4)(i)(E)	variances	NA – no variance being requested
(5)	general operating requirements	Applicable, no explanation required
(5)(a)	operating requirements -prohibition of chemicals that could cause leaks	Water or alkaline wastes will not cause carbon steel vessels, pumps, piping or piping gaskets to fail.
(5)(b)	operating requirements -work controls	Applicable, no explanation required
(5)(b)(i)	operating requirements -spill prevention	Equipment is totally contained, any leakage is into secondary containment by design.
(5)(b)(ii)	operating requirements -overfill prevention	See 4.5.3.
(5)(b)(iii)	operating requirements -overtopping protection by wave or wind	NA – not an uncovered tank
(5)(c)	operating requirements -leak response	Applicable-see response to subsection (7) requirements.
(5)(d)	operating requirements -labeling	Skids are labeled showing the tanks contain radioactive materials. Labels are visible from greater than 50 ft. away.
(5)(e)	operating requirements -prevention of vapors	See 4.7.1 response.
(6)	inspections	Applicable, no explanation required

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(6)(a)	inspection - schedule for overfill controls	Procedure TO-320-032 provides operating steps for batch tank. Overflow can only occur during active retrieval. High level alarm requires cessation of retrieval batch. Batch vessel instruments are calibrated per tank farm equipment calibration requirements. Instruments have calibration procedures and have calibration frequencies established.
(6)(b)	inspect - 1/day	Applicable – no explanation required
(6)(b)(i)	inspection - aboveground portions	System precludes daily internal inspection of skids due to high dose rates. Leak detectors verified operable prior to retrieval startup and are a fail-safe design.
(6)(b)(ii)	inspection - leak detection	Leak detectors verified operable prior to retrieval startup and are a fail-safe design.
(6)(b)(iii)	inspection - external	System precludes daily inspection of skids due to high dose rates. Skids are located above ground and are visible beyond dose rate barrier. Leak detectors verified operable prior to start and are a fail-safe design.
(6)(c)	inspection - cathodic protection	NA – no cathodic protection required for aboveground skids.
(6)(c)(i)	inspection - cathodic protection	NA – no cathodic protection required for aboveground skids.
(6)(c)(ii)	inspection - cathodic protection	NA – no cathodic protection required for aboveground skids.
(6)(d)	inspection – log	An operating log is maintained in the control room for the C-200 retrieval equipment.
(7)	leak response	Applicable, no explanation required
(7)(a)	leak response - cessation	See 4.5.3 and 4.6.3
(7)(b)	leak response -removal	See 4.5.3 and 4.6.3
(7)(b)(i)	leak response -removal	See 4.5.3 and 4.6.3
(7)(b)(ii)	leak response -removal	See 4.5.3 and 4.6.3
(7)(c)	leak response - containment	See 4.5.3 and 4.6.3
(7)(c)(i)	leak response – containment-prevent migration	See 4.5.3 and 4.6.3
(7)(c)(ii)	leak response – containment-remove visible contamination	See 4.5.3 and 4.6.3
(7)(d)	leak response - notification	See 4.5.3 and 4.6.3

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(7)(d)(i)	leak response - notification	See 4.5.3 and 4.6.3
(7)(d)(ii)	leak response - exemption	Applicable, no explanation required
(7)(d)(ii)(A)	leak response - exemption	Applicable, no explanation required
(7)(d)(ii)(B)	leak response - exemption	Applicable, no explanation required
(7)(d)(iii)	leak response -report	See 7.6.3
(7)(d)(iii)(A)	leak response -report	See 7.6.3
(7)(d)(iii)(B)	leak response -report	See 7.6.3
(7)(d)(iii)(c)	leak response -report	See 7.6.3
(7)(d)(iii)(D)	leak response -report	See 7.6.3
(7)(d)(iii)(E)	leak response -report	See 7.6.3
(7)(e)	secondary containment repair or closure	Applicable, no explanation required
(7)(e)(i)	close system if don't satisfy (7)(e)(ii) or (7)(e)(iii)	Applicable, no explanation required
(7)(e)(ii)	return to service when repair	Applicable, no explanation required
(7)(e)(iii)	return to service when repair	Applicable, no explanation required
(7)(e)(iv)	leak from component without secondary containment	NA – primary vessels and piping in skids all have secondary containment
(7)(f)	recertification after major repair	Applicable, no explanation required
(8)	closure	See Section 4.7.2.6
(8)(a)	closure	See Section 4.7.2.6
(8)(b)	closure	Likely NA, no contaminated soils should occur unless secondary containment leaks during dismantling. Such leaks should be easily cleaned up. If not, section applicable when equipment no longer needed, no explanation required at this time. If a release from the secondary containment were to occur it would be dispositioned in accordance with WAC 173-303-640 (7).

Table B.1. Compliance of C-200-Series Retrieval Vessel/Pump and Vacuum Skids, and Ancillary Equipment, with WAC 173-303-640 (11 Sheets)

Step	Subject	Compliance Information
(8)(c)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(8)(c)(i)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(8)(c)(ii)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(8)(c)(iii)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(8)(c)(iv)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(8)(c)(v)	closure-no secondary containment meeting (4)(b) through (f)	NA – secondary containment meets requirements
(9)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(9)(a)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(9)(a)(i)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(9)(a)(ii)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(9)(a)(iii)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(9)(b)	ignitable or reactive wastes	NA – not ignitable or reactive waste with materials of construction used
(10)	incompatible wastes	NA, only alkaline wastes and water are involved
(10)(a)	incompatible wastes	NA, only alkaline wastes and water are involved
(10)(b)	incompatible wastes	NA, only alkaline wastes and water are involved
(11)	air emission standards	See 4.7.1

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